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ENGINE

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2 Stroke Engine Torque Specifications

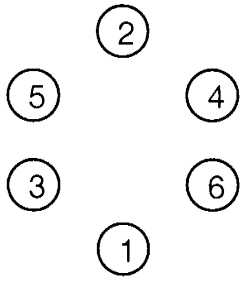
Fastener	Size	250 EC25PFE Ft. Lbs. (kg-m)	300 EC28PFE Ft. Lbs.(kg-m)	400 EC38PLE Ft. Lbs. (kg-m)
Cylinder Head Bolts	8mm	17-19(2.3-2.6)	17-19(2.3-2.6)	17-19(2.3-2.6)
Cylinder Base Bolts	10mm	24-28 (3.3-3.9)	24-28 (3.3-3.9)	24-28 (3.3-3.9)
Crankcase	8mm	17-18 (2.3-2.4)	17-18 (2.3-2.4)	17-18 (2.3-2.4)
Crankcase	6mm	6-8 (.8-1.1)	6-8 (.8-1.1)	6-8 (.8-1.1)
Crankshaft Slotted Nut	16mm	-	-	36–44(5.0-6.0)
Drive Clutch Bolt	7/16 - 20	40 (5.5)	40 (5.5)	40 (5.5)
Flywheel	16mm	44-54(6.0-7.5)	44-54 (6.0-7.5)	36-44 (5.0-6.0)
Recoil Housing	6mm	5-6.5 (.69-.90)	5-6.5 (.69-.90)	5-6.5 (.69-.90)
Spark Plug	14mm	14 (1.94)	14 (1.94)	14 (1.94)
Starter Motor	6mm	5-6.5 (.69-.90)	5-6.5 (.69-.90)	5-6.5 (.69-.90)
Stator Plate	6mm	5-6.5 (.69-.90)	5-6.5 (.69-.90)	5-6.5 (.69-.90)
Water Pump Impeller Nut	6mm	-	-	6–7 (.8-1.0)

4 Stroke Engine Torque Specifications

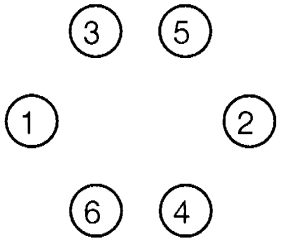
Cylinder Head Bolts	11mm	See Engine Assembly for torque procedure, page 3.82.		
	6mm	See Engine Assembly for torque procedure, page 3.82.		
Cylinder Base Bolts	10mm	45-49 ft. lbs.	6.21-6.76 kg-m	62.1-67.6 N-m
	6mm	5-6 ft. lbs.	.69-.828 kg-m	6.9-8.28 N-m
Crankcase	8mm	14-15 ft. lbs.	1.93-2.07 kg-m	19.3-20.7 N-m
Cam Chain Drive Sprocket	28mm	35-51 ft. lbs.	4.83-7.04 kg-m	48.3-70.4 N-m
Cam Chain Driven Sprocket	6mm	5-6 ft. lbs.	.69-.828 kg-m	6.9-8.28 N-m
Cam Chain Tensioner	6mm	5-6 ft. lbs.	.69-.828 kg-m	6.9-8.28 N-m
Cam Chain Tensioner Plug	11mm	14-19 ft. lbs.	1.93-2.62 kg-m	19.3-26.2 N-m
Rocker Arm Shaft Support	8mm	8-9 ft. lbs.	1.10-1.24 kg-m	11.0-12.4 N-m
Rocker Arm Adjuster Nut	6mm	6-7 ft. lbs.	.828-.966 kg-m	8.28-9.66 N-m
Water Pump Impeller Nut	6mm	5-6.5 ft. lbs.	.69-.897 kg-m	6.9-8.97 N-m
Water Pump Cover	6mm	5-6.5 ft. lbs.	.69-.897 kg-m	6.9-8.97 N-m
Carburetor Flange	8mm	12-14 ft. lbs.	1.66-1.93 kg-m	16.6-19.3 N-m
Oil Pump Mount Bolts	6mm	5-6.5 ft. lbs.	.69-.897 kg-m	6.9-8.97 N-m
Oil Pump Case Screws	5mm	2 ft. lbs.	.276 kg-m	27.6 N-m
Union (Breather)	1/8 PT	6.5-11 ft. lbs.	.897-1.52 kg-m	8.97-15.2 N-m
Union (Oil Hose)	1/8 PT	6.5-11 ft. lbs.	.897-1.52 kg-m	8.97-15.2 N-m
Union (Oil Filter)	20mm	36-43 ft. lbs.	4.97-5.93 kg-m	49.7-59.3 N-m
Oil Pressure Blind Plug	1/8 PT	6.5-11 ft. lbs.	.897-1.52 kg-m	8.97-15.2 N-m
Oil Delivery Pipe	12mm	18-25 ft. lbs.	2.48-3.45 kg-m	24.8-34.5 N-m
Oil Drain Bolt (Crankcase)	14mm	14-17 ft. lbs.	1.93-2.35 kg-m	19.3-23.5 N-m
Plug (One Way Valve)	11mm	14-19 ft. lbs.	1.93-2.62 kg-m	19.3-26.2 N-m
Stator Plate	6mm	5-6.5 ft. lbs.	.69-.897 kg-m	6.9-8.97 N-m
Flywheel	16mm	58-72 ft. lbs.	8.00-9.94 kg-m	80.0-99.4 N-m
Starter Motor	6mm	5-6.5 ft. lbs.	.69-.897 kg-m	6.9-8.97 N-m
Recoil Housing	6mm	5-6.5 ft. lbs.	.69-.897 kg-m	6.9-8.97 N-m
Spark Plug		14 ft. lbs.	1.94 kg-m	19.4 N-m

ENGINE
Engine Fastener Torque Patterns

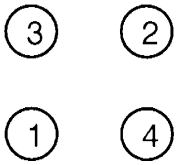
When torquing nuts, bolts and screws, a specific pattern should be followed to ensure that all parts are tightened evenly. The correct amount of turning force or tightness is determined by a torque wrench which is broken down into either inch or foot pounds.



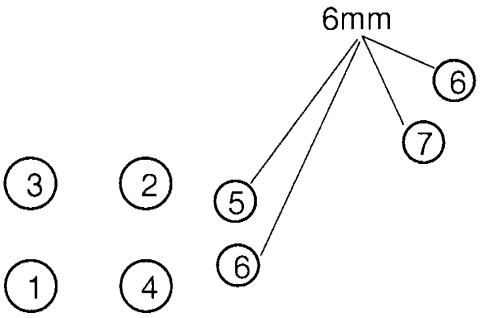
Cylinder Head
250 / 300



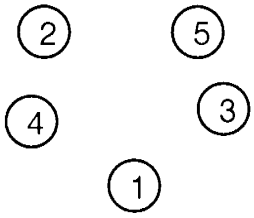
Cylinder Head
400



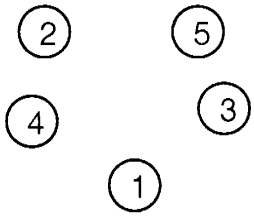
Cylinder Base
250 / 300 / 400



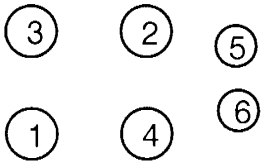
Cylinder Base
425 / 500



Crankcase
400L



Crankcase
250/300



Refer to page 3.82
for torque procedure.

Cylinder Head
425 / 500

1996 to Current Engine Specifications

Machine Model	Engine Model	Cyl. Disp. cc's	Bore mm / in.	Stroke mm/ in.	Ring End Gap in. (mm)	Piston Clearance in. (mm)	Clearance Svc. Limit in. (mm)	Engine Operating RPM
Trail Blazer Trail Boss	EC25PFE-09/11 EC25PFE-08/10	244	72/2.8346	60/2.362	.009-.018 (.23-.46)	.0011-.0021 (.03-.05)	.006 (.15)	5800 6000
Xpress 300 Xplorer 300 300	EC28PFE-01, 02	283	74.5/2.935	65/2.561	.012-.022 (.31-.56)	.0012-.0026 (.03-.07)	.006 (.15)	5600
Xpress 400 Xplorer 4x4 Sportsman 400 400 6x6	EC38PLE-04, 06	379	83/3.270	70/2.758	.007-.015 (.18-.38)	.0023-.0037 (.06-.09)	.006 (.15)	5700
Sport Scrambler 400	EC38PLE-05, 07, 09	379	83/3.270	70/2.758	.007-.015 (.18-.38)	.0023-.0037 (.06-.09)	.006 (.15)	5700 6000
Magnum 2x4 Magnum 4x4 Magnum 6x6	EH42PLE-01, 02	425	87.9/3.461	70/2.758	.008-.015 (.20-.38)	.0006-.0018 (.015-.046)	.0024 (.061)	6000
Sportsman 500 Xplorer 500 Big Boss 500 6x6	EH50PLE-01, 05, 06, 07	498	92/3.622	75/2.953	.008-.015 (.20-.38)	.0006-.0018 (.015-.046)	.0024 (.061)	6000
Scrambler 500	EH50PLE-02, 04	498	92/3.622	75/2.953	.008-.015 (.20-.38)	.0006-.0018 (.015-.046)	.0024 (.061)	6000

Piston Identification

Note the directional and identification marks when viewing the pistons from the top. The letter "F", " → ", " ▶" or **:** must always be toward the flywheel side of the engine. The other numbers are used for identification as to diameter, length and design. Two stroke rings are keystone design. Four stroke engine rings are rectangular profile. The numbers or letters on all rings (except 4-stroke oil control rings) must be positioned upward. See text for 4 stroke oil control ring upper rail installation. Use the information below to identify pistons and rings.

Engine Model No.	Oversize Available* (mm)	Piston Length	Standard Piston Identification
EC25PFE-08, 09, 10, 11	.25 .50 1.00	68 mm	3W, 4W
EC28PFE-01, 02	.25 .50	70 mm	28
EC38PLE-04, 05	.25 .50	78mm	38A
EC38PLE-06, 07	.25 .50	78mm	38B
EH42PL-01	.25 .50	66mm	B
EH50PL-01, 02, 03	.25 .50	72mm	C

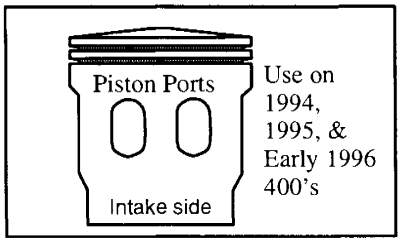
*

Pistons and rings marked 25 equal .25mm (.010") oversized
Pistons and rings marked 50 equal .50mm (.020") oversized
Pistons and rings marked 10 equal 1.0mm (.040") oversized (250 engines only)

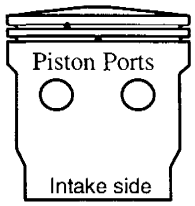
EC38PL Engines

Jetting Guidelines For Round-Port Pistons

Pistons for EC38PL engines shipped as service parts have round ports on the intake skirt. If you are replacing an oblong port piston with the new round port style, follow the instructions included with the piston or refer to this chart for quick reference. Without the jetting change the machine will run slightly rich on the main jet.



Use on 1994, 1995, & Early 1996 400's



Use on Late 1996 to current

This piston was shipped with:

1 200 Main Jet
1 230 Main Jet
1 6CEY6-3 Jet Needle.

A **#35 Pilot Jet** is **not supplied** with this piston kit, although a #35 is required if you install a round port piston in a 1995 Scrambler (EC38PLE-03 engine).

A round port piston along with the jetting changes shown effectively changes earlier model EC38PL engines to 1997 specifications for carburetion and engine operating characteristics. Jetting compensation for altitude and temperature will be the same as 1997 EC38PLE-06 engines or EC38PLE-07 (Sport, Scrambler) engines.

****In all cases the 6CEY6-3 Jet Needle (included with piston) should be installed if you replace an "oblong port" style piston with a "round port" style piston. Standard "E" clip position is #3.**

Year	Engine Type	Model	Original Piston Type	Original Main Jet	Need to Change Main Jet?	Need to Change Pilot Jet?
1994	EC38PL-01	ALL (EC38s)	**Oblong Ports	200	NO-Use Original	NO
1995	EC38PLE-01	400 2x4, Xplorer 4x4, Sportsman, 400 6x6	**Oblong Ports	200	NO-Use Original	NO
1995	EC38PLE-02	Sport	**Oblong Ports	200	NO-Use Original	NO
1995	EC38PLE-03	Scrambler	**Oblong Ports	240	**YES-Use 230 Main Jet**	**YES-Use *35 Pilot Jet**
Early 1996	EC38PLE-04	Xpress 400, Xplorer 400, Sportsman 4x4, 400 6x6	**Oblong Ports	210	**YES-Use 200 Main Jet**	NO
Late 1996	EC38PLE-04	Xpress 400, Xplorer 400, Sportsman 4x4, 400 6x6	Round Ports	200	NO-Use Original	NO
Early 1996	EC38PLE-05	Sport 4x4, Scrambler	**Oblong Ports	250	**YES-Use 230 Main Jet**	NO
Late 1996	EC38PLE-05	Sport 4x4, Scrambler	Round Ports	230	NO-Use Original	NO
1997	EC38PLE-06	Xpress 400, Xplorer 400, Sportsman 4x4, 400 6x6	Round Ports	200	NO-Use Original	NO
1997	EC38PLE-07	Sport 400, Scrambler 4x4	Round Ports	230	NO-Use Original	NO

NOTES

EH42PL / EH50PL Engine Service Data

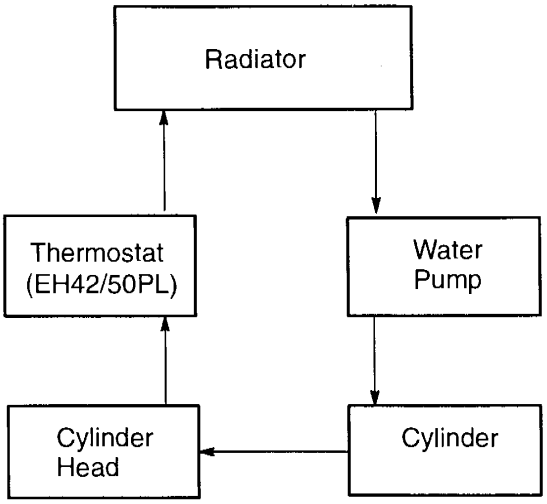
Cylinder Head / Valve				EH42PL	EH50PL
Rocker Arm	Rocker arm ID			.8669-.8678" (22.020-22.041 mm)	.8669-.8678" (22.020-22.041 mm)
	Rocker shaft OD			.8656-.8661" (21.987-22.0 mm)	.8656-.8661" (21.987-22.0 mm)
	Rocker shaft Oil Clearance		Std	.0008-.0021" (.020-.054 mm)	.0008-.0021" (.020-.054 mm)
			Limit	.0039" (.10 mm)	.0039" (.10 mm)
Camshaft	Cam lobe height	In	Std	1.2884-1.2924" (32.726-32.826 mm)	1.2884-1.2924" (32.726-32.826 mm)
			Limit	1.2766" (32.426 mm)	1.2766" (32.426 mm)
		Ex	Std	1.2884-1.2924" (32.726-32.826 mm)	1.2884-1.2924" (32.726-32.826 mm)
			Limit	1.2766" (32.426 mm)	1.2766" (32.426 mm)
	Camshaft journal OD		Mag	1.4935-1.4941" (37.935-37.950 mm)	1.4935-1.4941" (37.935-37.950 mm)
			PTO	1.4935-1.4941" (37.935-37.950 mm)	1.4935-1.4941" (37.935-37.950 mm)
	Camshaft journal bore ID		Mag	1.4963-1.4970" (38.005-38.025 mm)	1.4963-1.4970" (38.005-38.025 mm)
			PTO	1.4963-1.4970" (38.005-38.025 mm)	1.4963-1.4970" (38.005-38.025 mm)
	Camshaft Oil clearance		Std	.0022-.0035" (.055-.090 mm)	.0022-.0035" (.055-.090 mm)
			Limit	.0039" (.10 mm)	.0039" (.10 mm)
Cylinder Head	Surface warpage limit			.0020" (.05 mm)	.0020" (.05 mm)
	Standard height			3.870" (98.3 mm)	3.870" (98.3 mm)
Valve Seat	Contacting width	In	Std	.028" (.7 mm)	.028" (.7 mm)
			Limit	.055" (1.4 mm)	.055" (1.4 mm)
		Ex	Std	.039" (1.0 mm)	.039" (1.0 mm)
			Limit	.071" (1.8 mm)	.071" (1.8 mm)
Valve Guide	Inner diameter			.2362-.2367" (6.0-6.012 mm)	.2362-.2367" (6.0-6.012 mm)
	Protrusion above head			.689-.709" (17.5-18.0 mm)	.689-.709" (17.5-18.0 mm)
Valve	Margin thickness	In	Std	.039" (1.0 mm)	.039" (1.0 mm)
			Limit	.031" (.8 mm)	.031" (.8 mm)
		Ex	Std	.047" (1.2 mm)	.047" (1.2 mm)
			Limit	.031" (.8 mm)	.031" (.8 mm)
Valve	Stem diameter		In	.2343-.2348" (5.950-5.965 mm)	.2343-.2348" (5.950-5.965 mm)
			Ex	.2341-.2346" (5.945-5.960 mm)	.2341-.2346" (5.945-5.960 mm)
	Stem oil clearance	Std	In	.0014-.0024" (.035-.062 mm)	.0014-.0024" (.035-.062 mm)
			Ex	.0016-.0026" (.040-.067 mm)	.0016-.0026" (.040-.067 mm)
		Limit		.0059" (.15 mm)	.0059" (.15 mm)
	Overall length		In	3.976" (101.0 mm)	3.976" (101.0 mm)
			Ex	3.984" (101.2 mm)	3.984" (101.2 mm)

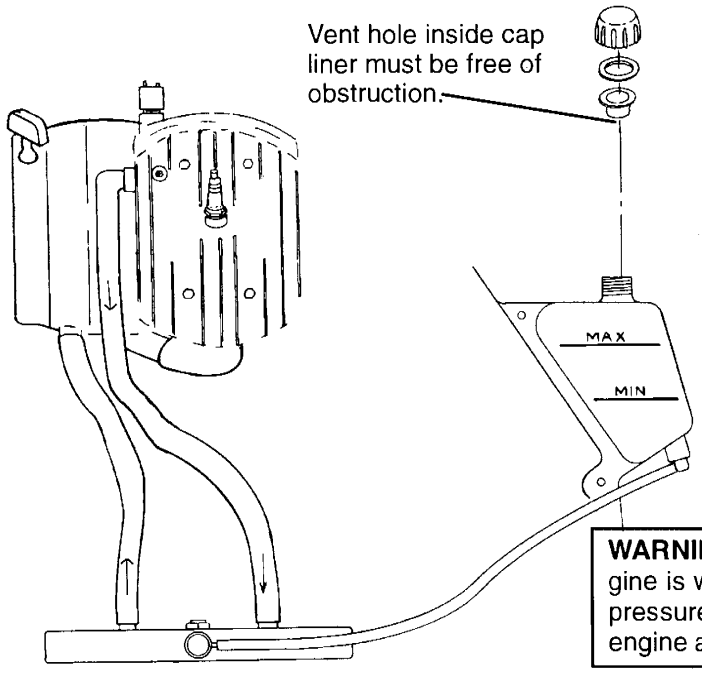
Valve Spring	Free length	Orange Paint	Std	1.7342" (44.05 mm)
			Limit	1.656" (42.05 mm)
		Yellow Paint	Std	1.654" (42.0 mm)
			Limit	1.575" (40.0 mm)
	Squareness			.075" (1.9 mm) 2.5°

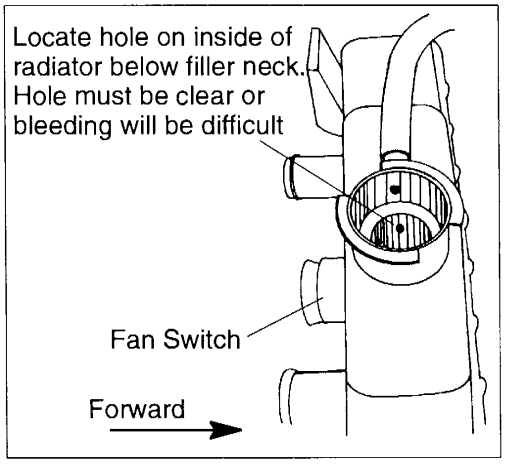
EH42PL / EH50PL Engine Service Data

Cylinder / Piston / Connecting Rod				EH42PL	EH50PL
Cylinder	Surface warpage limit (mating with cylinder head)			.0020" (.05 mm)	.0020" (.05 mm)
	Cylinder bore		Std	3.4606-3.4614" (87.900-87.920 mm)	3.6216-3.6224" (91.99-92.01 mm)
	Taper limit			.0020" (.050 mm)	.0020" (.050 mm)
	Out of round limit			.0020" (.050 mm)	.0020" (.050 mm)
	Piston clearance		Std	.0006-.0018" (.015-.045 mm)	.0006-.0018" (.015-.045 mm)
			Limit	.0024" (.060 mm)	.0024" (.060 mm)
	Boring limit			.020" (.5 mm)	.020" (.5 mm)
Piston	Outer diameter	Std		3.4596-3.4600" (87.875-87.885 mm)	3.6206-3.6210" (91.96-91.97 mm)
		.0098" (.25 mm) OS		3.4695-3.4699" (88.125-88.135 mm)	3.6304-3.6310 (92.21-92.23 mm)
		.0197" (.50 mm) OS		3.4793-3.4797" (88.375-88.385 mm)	3.6403-3.6407 (92.46-92.47 mm)
	Standard inner diameter of piston pin bore			.9055-.9057" (23.0-23.006 mm)	.9055-.9057" (23.0-23.006 mm)
Piston Pin	Outer diameter			.9053-.9055" (22.994-23.0 mm)	.9053-.9055" (22.994-23.0 mm)
	Standard clearance-piston pin to pin bore			.0002-.0003" (.004-.008 mm)	.0002-.0003" (.004-.008 mm)
	Degree of fit			Piston pin must be a push (by hand) fit at 68° F (20° C)	
Piston Ring	Piston ring installed gap	Top ring	Std	.0079-.0138" (.20-.36 mm)	.0079-.0138" (.20-.36 mm)
			Limit	.039" (1.0 mm)	.039" (1.0 mm)
		Second ring	Std	.0079-.0138" (.20-.36 mm)	.0079-.0138" (.20-.36 mm)
			Limit	.039" (1.0 mm)	.039" (1.0 mm)
		Oil ring	Std	.0079-.0276" (.20-.70 mm)	.0079-.0276" (.20-.70 mm)
			Limit	.059" (1.5 mm)	.059" (1.5 mm)
Piston Ring	Standard clearance - piston ring to ring groove	Top ring	Std	.0016-.0031" (.040-.080 mm)	.0016-.0031" (.040-.080 mm)
			Limit	.0059" (.15 mm)	.0059" (.15 mm)
		Second ring	Std	.0012-.0028" (.030-.070 mm)	.0012-.0028" (.030-.070 mm)
			Limit	.0059" (.15 mm)	.0059" (.15 mm)
Connecting Rod	Connecting rod small end ID			.9058-.9063" (23.007-23.020 mm)	.9058-.9063" (23.007-23.020 mm)
	Connecting rod small end radial clearance		Std	.0003-.0010" (.007-.026 mm)	.0003-.0010" (.007-.026 mm)
			Limit	.0020" (.05 mm)	.0020" (.05 mm)
	Connecting rod big end side clearance		Std	.0039-.0256" (.1-.65 mm)	.0039-.0256" (.1-.65 mm)
			Limit	.0315" (.80 mm)	.0315" (.80 mm)
	Connecting rod big end radial clearance		Std	.0004-.0015" (.011-.038 mm)	.0004-.0015" (.011-.038 mm)
			Limit	.0020" (.05 mm)	.0020" (.05 mm)
Crankshaft	Crankshaft runout limit			.0024" (.06 mm)	.0024" (.06 mm)

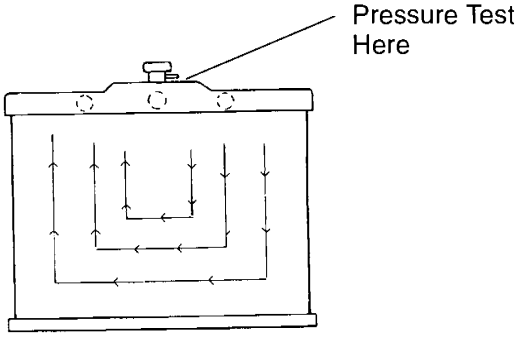
KEY - Std: Standard; OS: Oversize; ID: Inner Diameter; OD: Outer Diameter; Mag: Magneto Side; PTO: Power Take Off Side







WARNING: Never remove radiator cap when engine is warm or hot. The cooling system is under pressure and serious burns may result. Allow the engine and cooling system to cool before servicing.

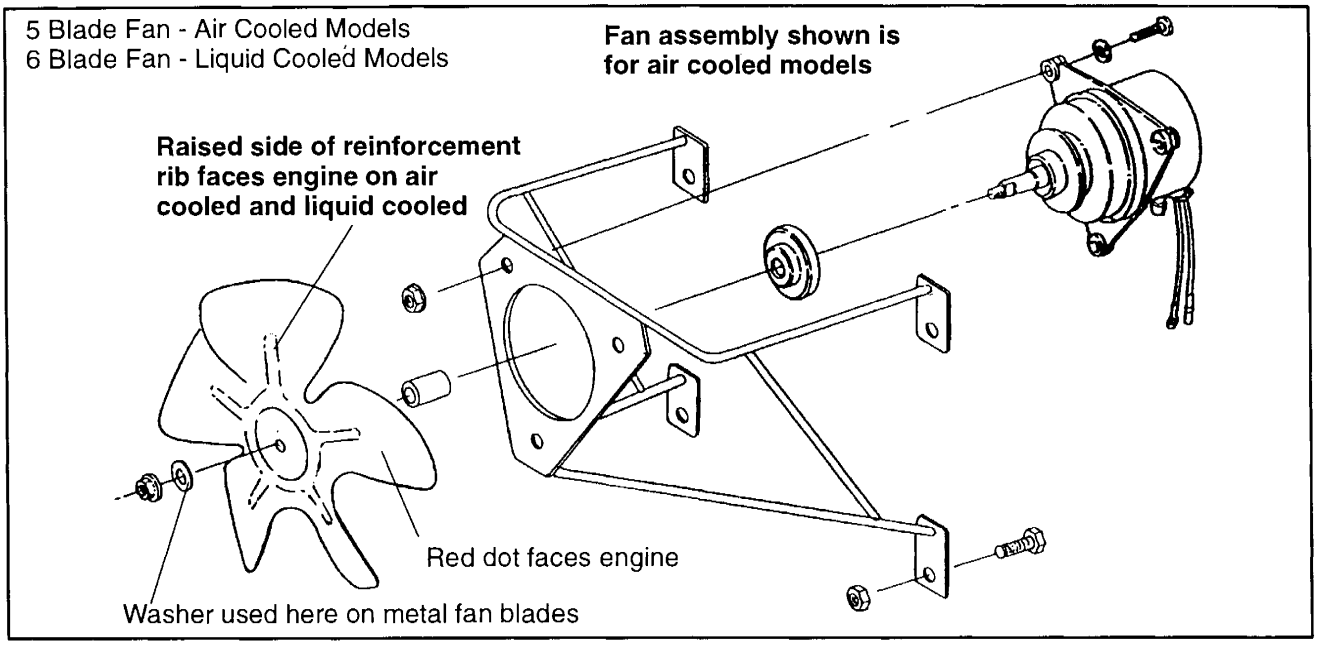


System Pressure Test

1. Remove radiator cap access panel from front of headlamp housing.
2. Remove recovery bottle hose from radiator.
3. Connect a Mity Vac™ (PN 2870975) to radiator and pressurize system to 10 PSI. The system must retain 10 lbs of pressure for five minutes or longer. If pressure loss is evident within five minutes, check radiator, all cooling system hoses and clamps, or water pump seal.

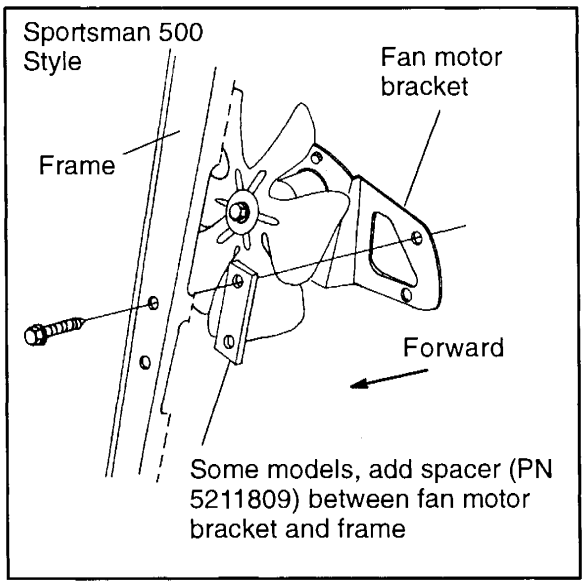
Radiator Cap Pressure Test

1. Remove radiator cap and test using a cap tester (commercially available).
2. The radiator cap relief pressure is 13 lbs. for all models.


5 Blade Fan - Air Cooled Models
6 Blade Fan - Liquid Cooled Models
Fan assembly shown is for air cooled models
Raised side of reinforcement rib faces engine on air cooled and liquid cooled
Red dot faces engine
Washer used here on metal fan blades

Recommended Coolant

Use only high quality antifreeze/coolant mixed with *distilled* water in a 50/50 or 60/40 ratio, depending on freeze protection required in your area. **CAUTION:** Using tap water in the cooling system will lead to a buildup of deposits which may restrict coolant flow and reduce heat dissipation, resulting in possible engine damage. Polaris Premium 60/40 Antifreeze/Coolant is recommended for use in all cooling systems, and comes pre-mixed and ready to use.


Sportsman 500 Style
Fan motor bracket
Frame
Forward
Some models, add spacer (PN 5211809) between fan motor bracket and frame

Cooling System Specifications

	250/300	Scrambler and Sport	Liquid Cooled Except Scrambler and Sport
Fan Switch (Off) Fan Switch (On)	210° F (99° C) ± 10° 235° F (113° C)	154° F (68° C) ± 5° 174° F (79° C)	175° F (79° C) ± 5° 190° F (88° C)
Hot Light On - 4 Strokes	-	-	221° F (105° C)
Hot Light On - 2 Strokes	-	205° F (96° C)	205° F (96° C)
System Capacity	-	2.25 Quarts	2.25 Quarts
Radiator Cap Relief Pressure	-	13 PSI	13 PSI

ENGINE
2 Stroke Engine Removal

The following components can be serviced or removed with the engine installed in the frame:

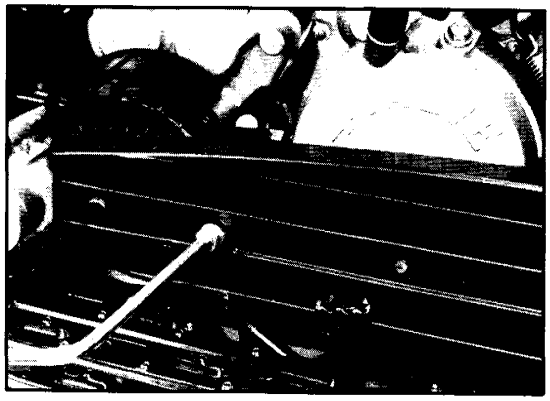
- Flywheel
- Alternator/Stator
- Starter Motor/Starter Drive
- Cylinder Head
- Cylinder
- Piston/Rings
- Oil pump (250/400L)
- Counterbalancer Assembly (400L engines)
- Water pump

The following components require engine removal for service:

- Connecting Rod
- Crankshaft
- Crankshaft Main Bearings
- Crankcase
- Oil pump (300)

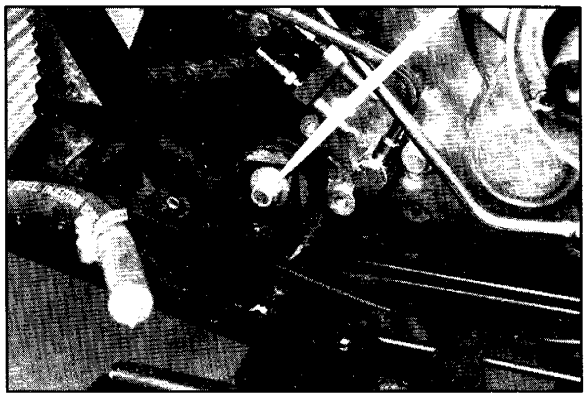
Engine Removal Preparation, Typical (2 Stroke)

1. Clean work area.
2. Thoroughly clean the ATV engine and chassis.
3. Disconnect battery negative (-) cable.
4. Remove the following parts. Refer to the Body Chapter for removal procedures.
   - Seat
   - Left and Right Side Covers
   - Fuel Tank Cover
   - Fuel Tank (see Fuel System Chapter)
5. Disconnect oil pump cable (2-Strokes).
6. Disconnect spark plug high tension lead.
7. Remove springs from exhaust pipe and remove pipe.
8. Remove air pre-cleaner and duct.
9. Remove airbox.
10. Remove carburetor.
11. Insert a shop towel into the carburetor flange to prevent dirt from entering the intake port.
12. Loosen auxiliary brake adjuster locknut, remove adjusting bolt and brake actuator arm.
13. Remove center chain guard bolt, two screws, and chain guard on AWD models.
14. Remove center drive and driven sprocket bolts and remove chain and sprockets as an assembly.
15. Refer to PVT section page 6.9 for procedure to remove inner PVT cover.

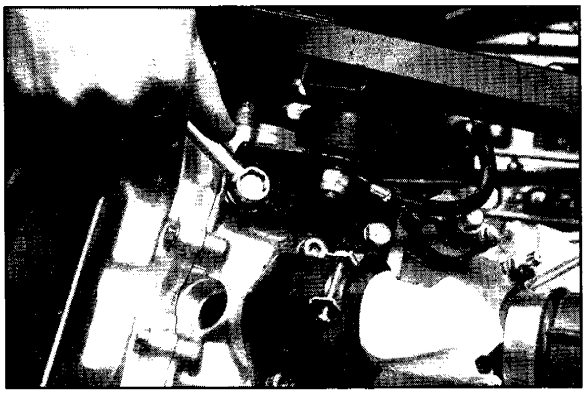


Engine Removal Preparation, Cont.

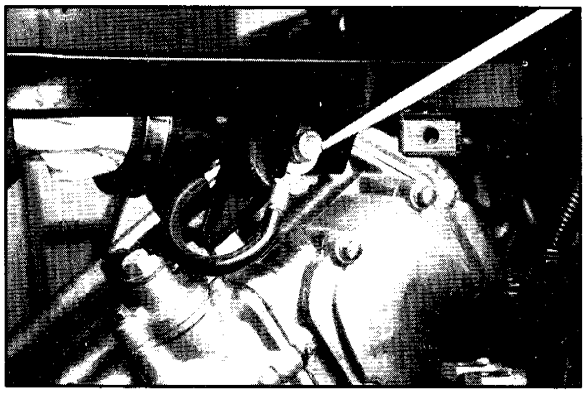
16. Starter motor. Note ground cable location. Mark positive (+) cable mounting angle and remove cable.
17. Remove transmission linkage rods from shift selector and secure out of the way.
18. Disconnect coolant temp sender wire (where applicable).
19. Remove nut, ground cable and washer from the upper right engine mount.



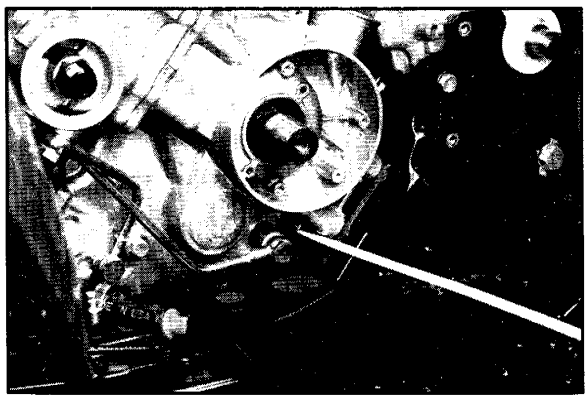
20. Remove the two upper engine mount plate bolts and remove the plate and ground cable (where applicable).



21. Remove nut and washer from lower front engine mount.

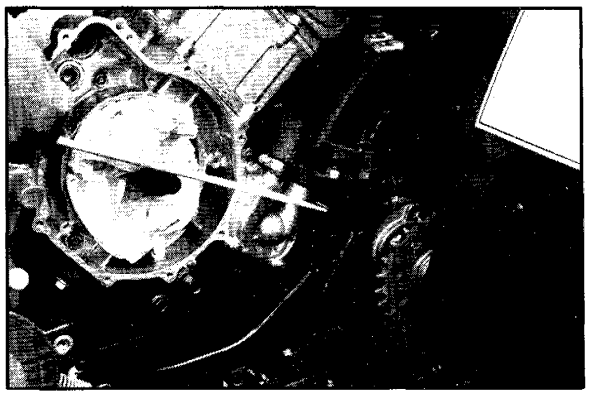


22. Loosen nut on slotted rear engine mount plate and back it out to the end of the stud.

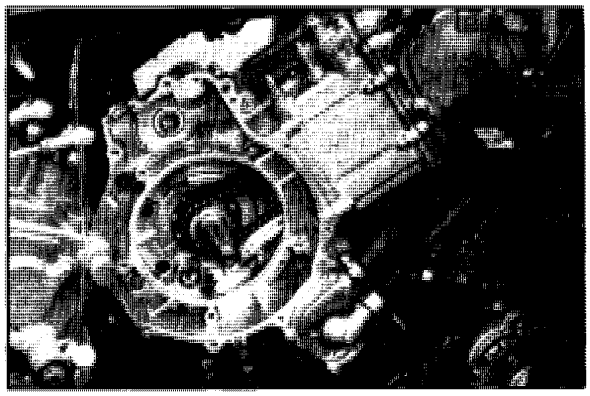


Engine Removal Preparation, Cont.

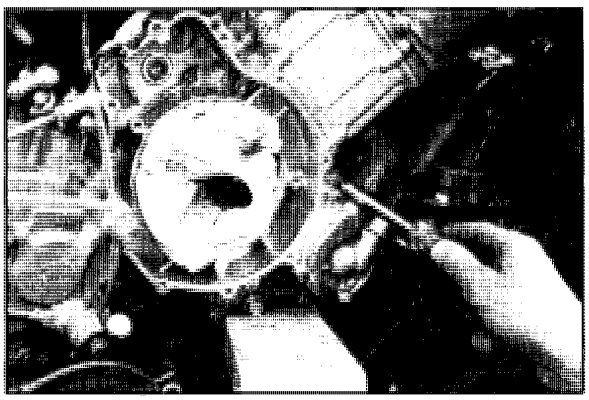
23. Move top of engine to left until coolant supply hose clamp clears frame at water pump fitting.



24. Lift and twist engine clockwise until lower left engine mount stud is clear of frame mount and the lower right coolant hose clamp clears frame tube.



25. Support engine in this position with a suitable support, such as a board or a 2x4.
26. Place a drain pan beneath area to catch coolant.
27. Clamp coolant inlet hose leading from radiator to pump to reduce coolant spillage.
28. Remove hose from water pump inlet and place in container. Release clamp from hose and allow hose to drain completely.
29. Lift back of engine while rotating front of engine clockwise and remove engine from left side of frame.



Engine Installation Notes (2 Stroke)

Bleed Cooling System

1. Fill coolant reservoir tank to full mark.
2. Loosen bleed screw at top of cylinder head until all air is purged from coolant system. Tighten bleed screw.
3. Install radiator cap and squeeze coolant lines to force air out of system.

NOTE: Radiator must be full or coolant will not circulate, and reservoir will not refill radiator.

4. Remove cap and add coolant if necessary.
5. After reassembly is complete, start engine and observe coolant level in the radiator. Allow air to purge and top off as necessary. Reinstall radiator cap and bring engine to operating temp. Check level in reservoir tank after engine is cool and add coolant if necessary.

Transmission

1. Readjust transmission shift linkage as outlined in Transmission Chapter page 8.3.

Exhaust

1. Replace exhaust gaskets. Seal connections with high temp silicone sealant.
2. Check to be sure all springs are in good condition.

Engine Break In Period (2 Strokes)

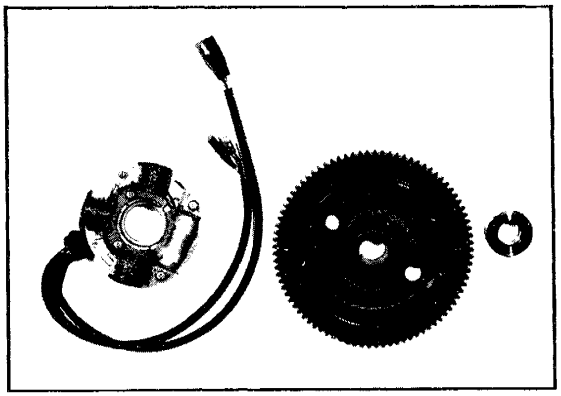
1. Pre-mix first tank of fuel at a 40:1 ratio with Polaris Premium Synthetic 2 Cycle Lubricant. Verify proper oil usage from oil tank during the first tank of fuel.
2. Avoid prolonged idle or periods of sustained full throttle. Vary throttle settings.

Disassembly

1. Remove the flywheel nut and flywheel with Flywheel Puller (PN 2871043). Remove stator assembly.

Flywheel Puller

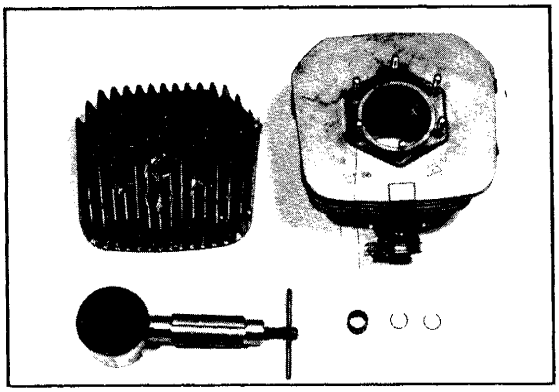
PN 2871043



2. Remove cylinder head and cylinder. Remove piston pin clips. Use Piston Pin Puller (PN 2870386) to remove piston pin from piston.

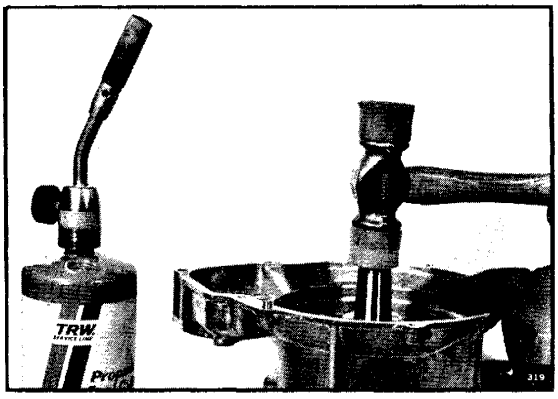
Piston Pin Puller

PN 2870386

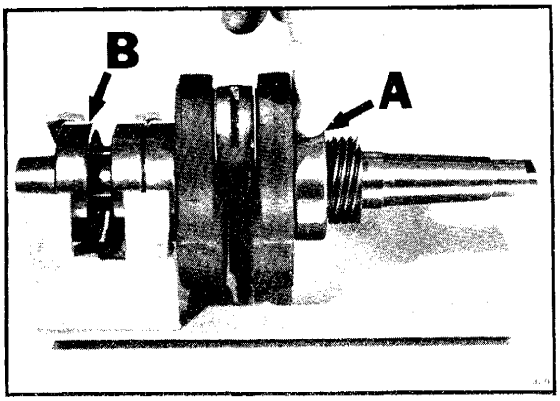


3. Inspect connecting rod small end and bearing; piston, piston pin, cylinder bore as shown on page 3.33 - 3.34b.

4. Remove the crankcase half attaching bolts. Heat crankcase in the bearing support areas. After applying heat, tap on PTO end and magneto end to separate case half from crankshaft.



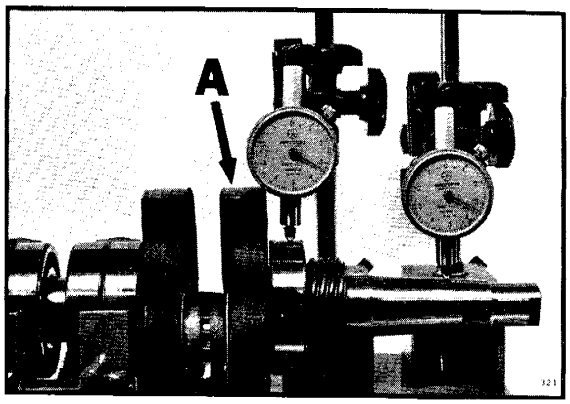
5. After removing the crankshaft, thoroughly clean the bearings and lubricate. Check bearing condition by pressing on and rotating the outer race (A). If the bearing(s) feel rough they must be replaced. Check the crankshaft runout by sliding a bearing onto the PTO end (B) and clamping the shaft into the special holding fixture (PN 2870710). The shaft should be straightened to .002" (.05 mm) or less.



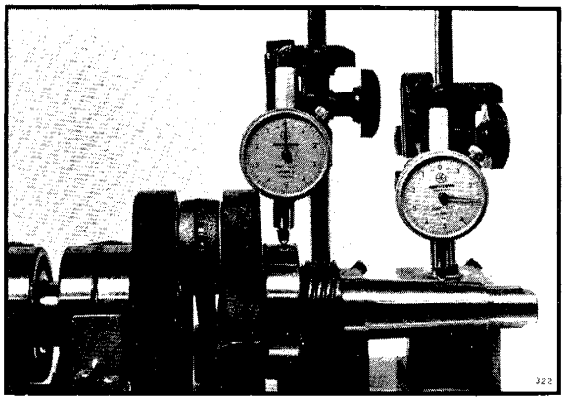
Crankshaft Alignment

When the crankshaft runout exceeds .005″ (.15 mm) it must be straightened or replaced. To straighten a crankshaft the crank wheel(s) must be relocated on the lower rod pin. The four basic movements which may be required to realign the crankshaft are listed below.

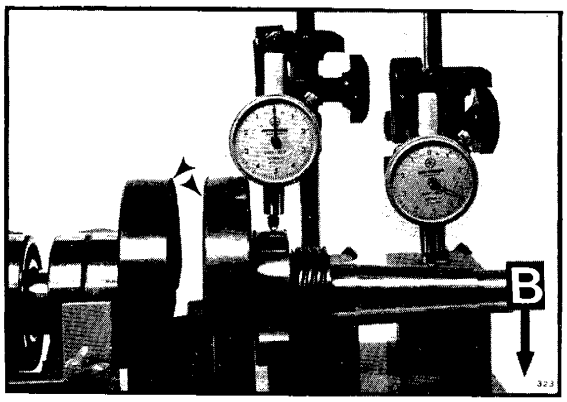
1. If the dial indicators are moving in the same direction and approximately the same amount while the shaft is rotated, the crankshaft has twisted on the lower rod pin. To correct this, remove the shaft from the fixture and strike the crank wheel on the high spot (A). This will rotate the wheel on the lower rod pin.



2. If the right side indicator is moving more than the left indicator while turning the shaft, and the high spot is found with the rod in this position (see photo at right), the crankshaft wheels will have to be squeezed together. Remove the shaft from the fixture. Locate the high spot and squeeze directly opposite from it using a large channel lock pliers or a vise. Arrows show direction of force to be applied.



3. If the right side indicator is moving more than the left indicator while turning the shaft, and the high spot is found with the rod in this position (see photo at right), the crankshaft wheels will have to be spread apart. Place a large chisel between the wheels and force the chisel downward. This will open the wheels and bring the end of the shaft down (B). Arrows show the direction of force to be applied.



4. If the indicators are moving in opposite directions while turning the shaft, the shaft is twisted. To correct this, remove the shaft from the fixture and strike the high spot found on the left side indicator.

NOTE: Squeezing the crank wheels is always done opposite the high spot. Spreading the crank wheels is always done at the high spot. Twisting the crank wheel by striking it is always done at a right angle to the lower rod pin, and at the high spot.

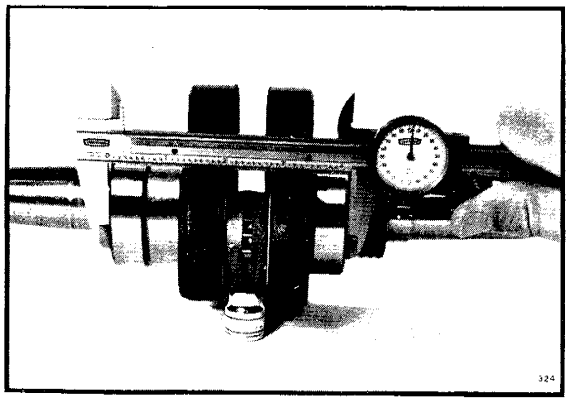
Assembly

Before reassembling the crankcase, the following steps should be performed to determine the amount of crankshaft end play. Excessive end play will cause the engine to be noisy at idle and slow speeds. Too little end play will side load the main bearings, which may cause premature bearing failure.

Measure Crankshaft Width – Bearings Installed

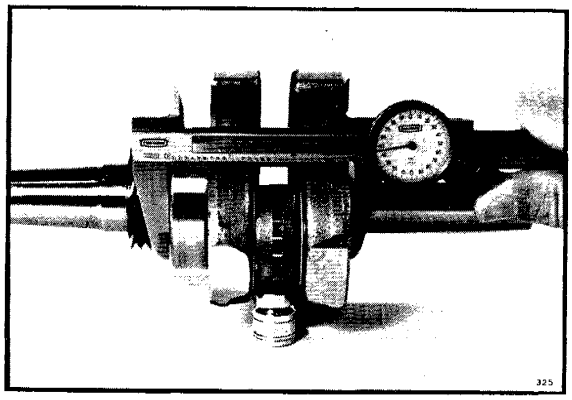
1. Measure distance from outer edge of PTO end bearing race to outer edge of mag side bearing race. Record measurement.

If bearings and spacers are already installed, measure distance as shown in photo at right, then proceed to Step 5.

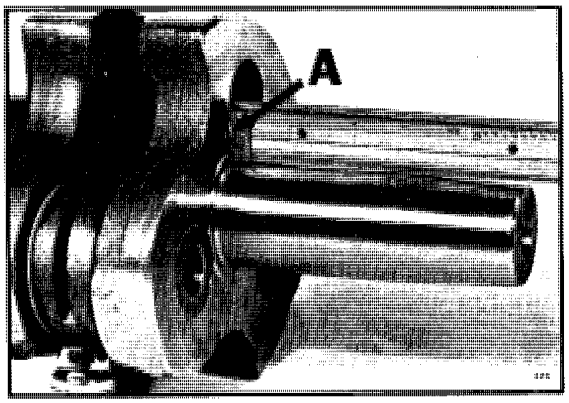


or...

If PTO end bearings have not yet been installed, measure distance as shown in photo at right, then proceed to Step 2.



2. Measure distance from crank wheel to bearing seating surface (A). Record measurement.

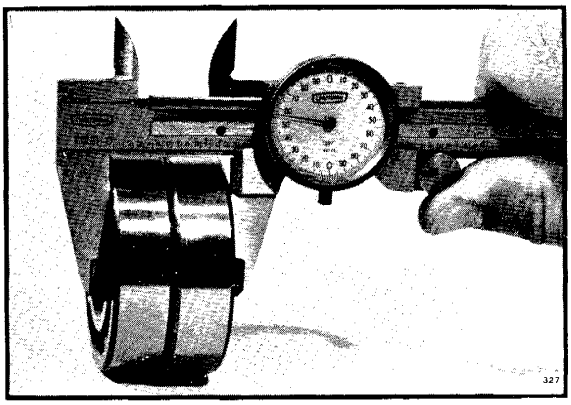


Assembly, Cont.

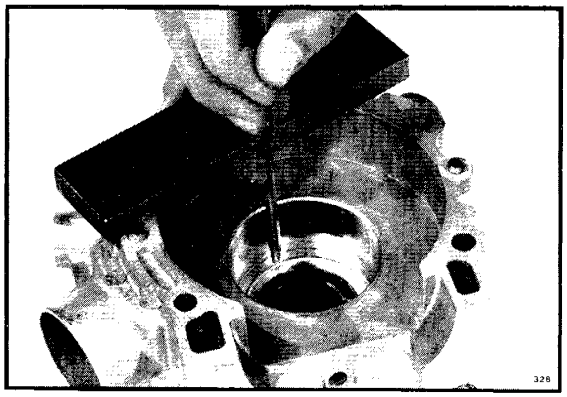
Correct crankshaft end play is .008″ - .016″ (.2 - .4 mm). End play is adjusted by adding or subtracting spacer washers from between the inner PTO end bearing and the crank wheel. Two different thickness spacers are available for EC 25 and EC28 engines:
For all EC25PF (except late 1998) - PN 3083629 - .008″ (.2 mm); and PN 3083630 - .004″ (.1 mm).
For late 1998 EC25PF and All EC28PF - PN 3084778 - .008″ (.2 mm); and PN 3084779 - .012″ (.3 mm).

3. Measure width of main bearing outer races with bearings positioned as shown. Add the thickness of the spacer between the bearings (if applicable). Record measurement.

4. Add all recorded measurements from Steps 1, 2, and 3 and record the total on line A below. If PTO bearings were assembled on crankshaft, record the measurement from Step 1.



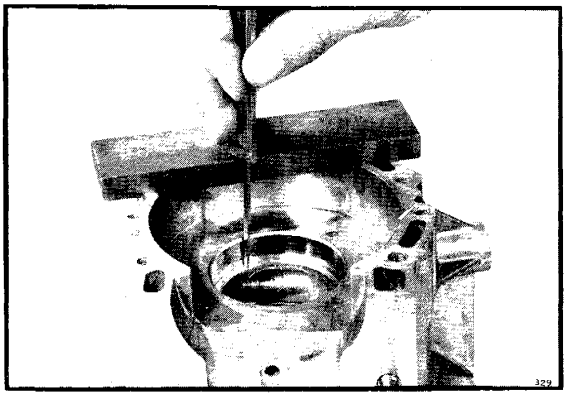
5. Measure PTO crankcase half as shown to determine depth of case. Place a piece of flat stock on the case mating surface and measure from this surface to the bearing seating surface. Subtract thickness of flat stock and record the measurement on line B below.



6. Measure magneto side case half using the same procedure. Record measurement on line C below. (Remember to subtract thickness of flat stock.)

7. Add the readings from steps 5 and 6 and record on line D. Subtract line A from line D. The result is the amount of crankshaft end play.

8. If adjustment is required, determine the amount of spacers needed to achieve proper end play. Install spacers on crankshaft followed by PTO bearings.



Connecting Rod Side Clearance

1. Measure clearance between lower rod and counterweight with a feeler gauge (connecting rod big end side clearance). New measurement should be between .016″-.020″ (.4-.5 mm). Clearance should not exceed .036″ (.9mm).

Total from Step 1, 2, and 3. (or from Step 1 only if PTO bearings were installed). **(A)**_____

Step 5 Result **(B)**_____

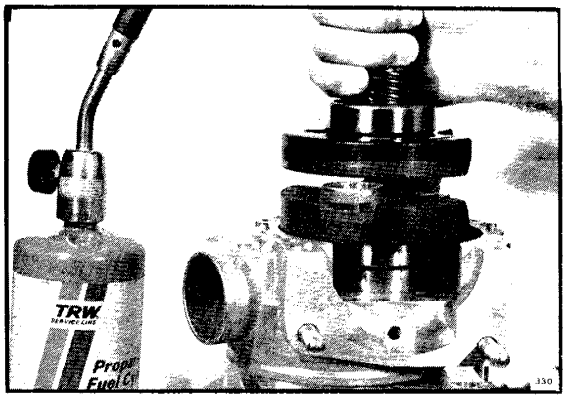
Step 6 Result **(C)**_____

Line B and Line C = **(D)** _____

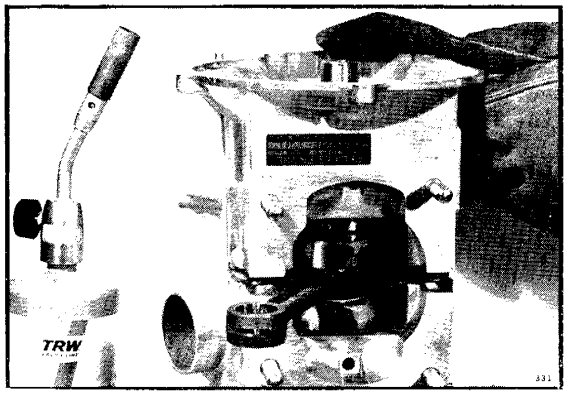
Line D – Line A = End Play _____

Assembly, Cont.

10. Remove crankcase end seals and thoroughly clean the case half mating surfaces.
11. Heat PTO side case half until it is hot to the touch.
12. Reinstall crankshaft into heated case.



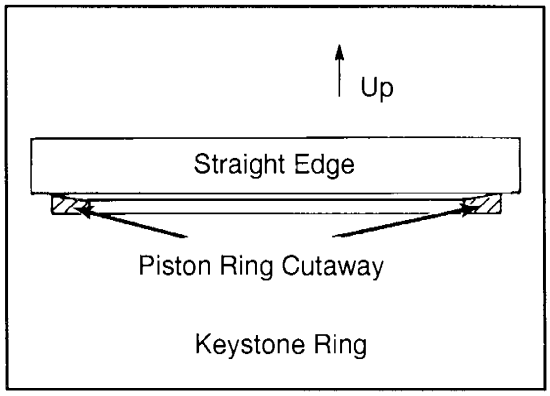
13. Heat mag side case half until it is hot to the touch.
14. Place Loctite 518 gasket eliminator on one of the case halves.
15. Reinstall the mag side half.



16. Torque case half attaching bolts in three steps to 17 ft. lbs. (2.3 kg-m) following pattern shown on page 3.2.

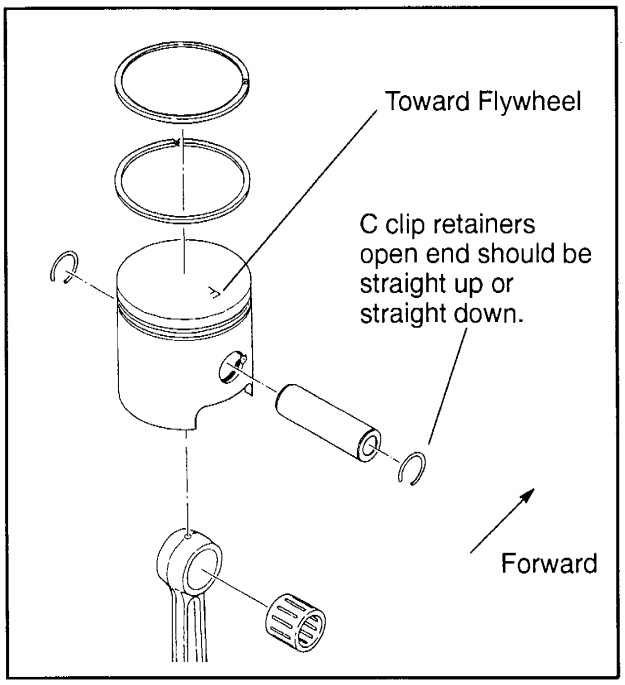
NOTE: Before proceeding, check piston to cylinder clearance and ring end gap (page 3.34) and cylinder honing procedures (page 3.33).

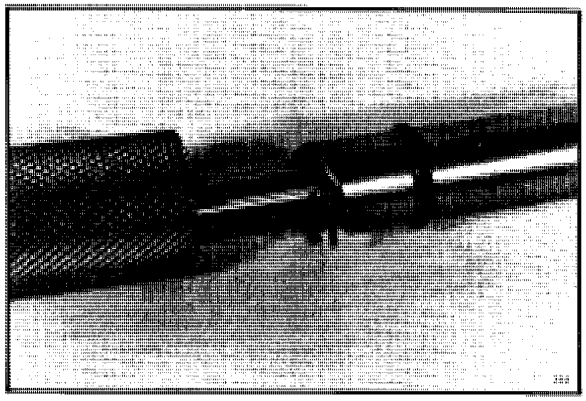
17. Install piston rings, beveled side up, onto piston. Keystone rings are beveled to the inside. This bevel must be toward the top of the piston (letter and/or number marks near end gap of ring face upward.



Assembly, Cont.

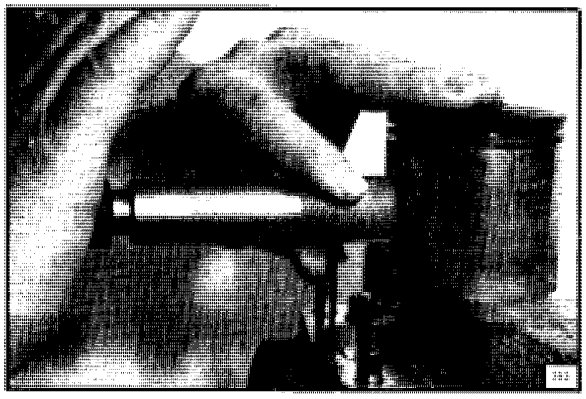
18. Position C clip onto driver (PN 2870773) with open end down as shown, Slide barrel over driver.





19. Install guide pin at the driver into the piston pin and position the barrel up against the piston. While holding the barrel against the piston, push the driver in until you hear the clip engage into the piston groove. Visually inspect the C-clip to be sure it is fully seated.

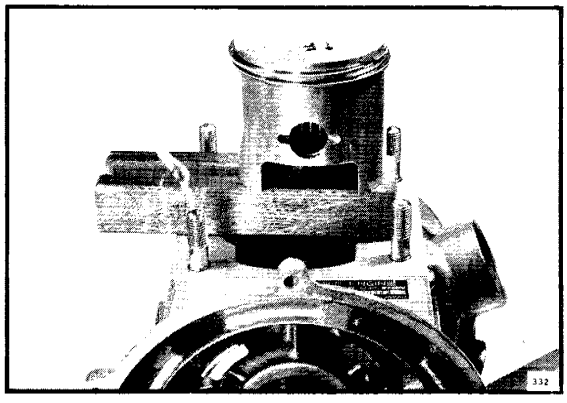
20. Rotate driver to complete engagement of clip.



21. Reinstall piston onto rod with "F" mark or →toward the magneto side of the engine. Support with support block.

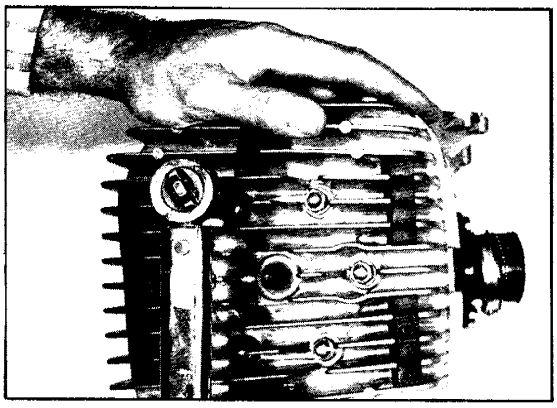
22. Lubricate piston pin and pin bearing.

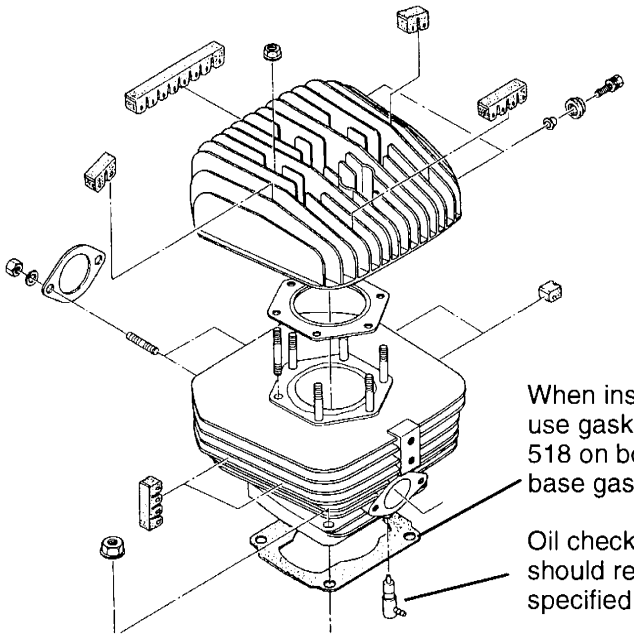
23. Reinstall piston pin.



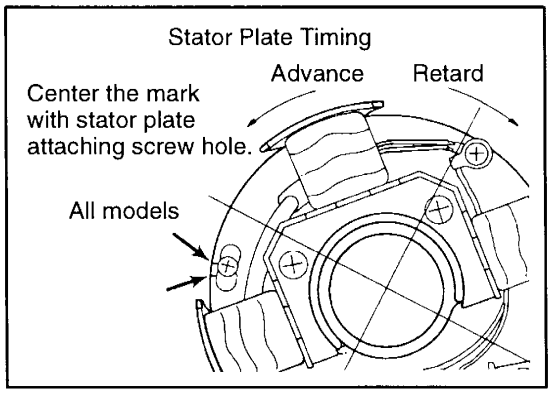
Assembly, Cont.

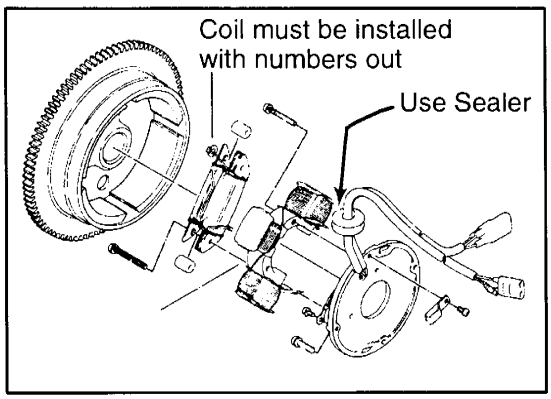
2. Apply Loctite No. 518 Gasket Eliminator to both sides of the cylinder base gasket. Install the base gasket and cylinder. Torque the cylinder base nuts in 3 steps to 28 ft. lbs. (3.9 kg-m). Install the head gasket and head. Torque nuts to 20 ft. lbs. (2.8 kg-m) following pattern on page 3.2.




When installing base gasket use gasket eliminator no. 518 on both sides of the base gasket.
Oil check valve should release as specified below.

1. Reinstall stator plate and align timing marks.
2. Reinstall flywheel.
3. Reinstall magneto housing.
4. Torque flywheel bolt to 44-62 ft. lbs. (6.08-8.57 kg-m).
5. Reinstall recoil starter assembly.

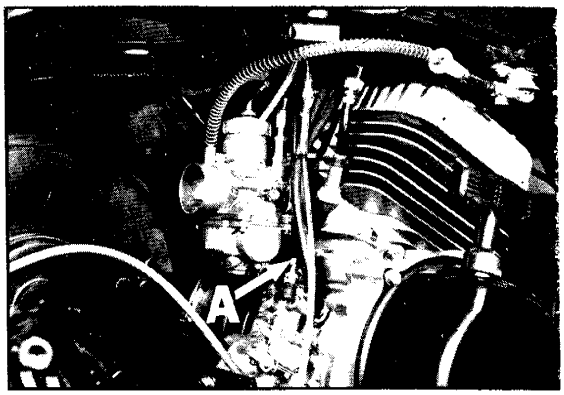




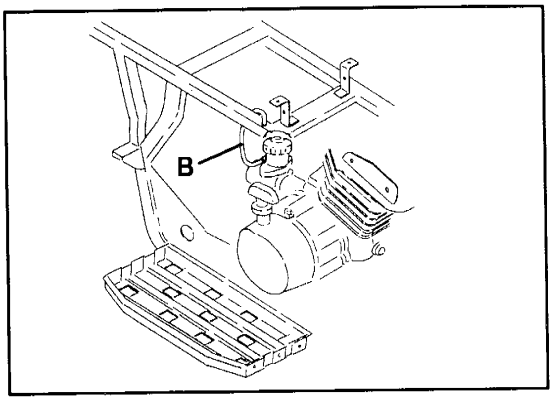
6. Seal wire harness grommet to crankcase using RTV silicone sealant.
7. Refer to electrical section of this manual for starter motor inspection. Reinstall starter motor.

Installation

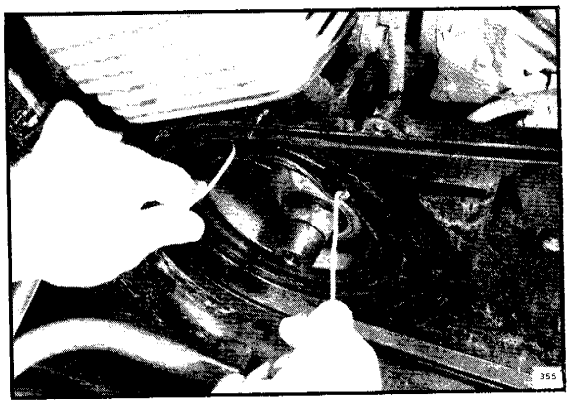
1. The engine can be reinstalled into the frame and secured. The oil pump and carburetor can also be assembled onto the engine. Bleed the oil pump of trapped air by loosening the bleed screw (A) for a few seconds, then tighten. Install the air box and filter element. **NOTE:** If the crankcase or oil pump have been replaced, check the oil pump end play as outlined on page 3.20.



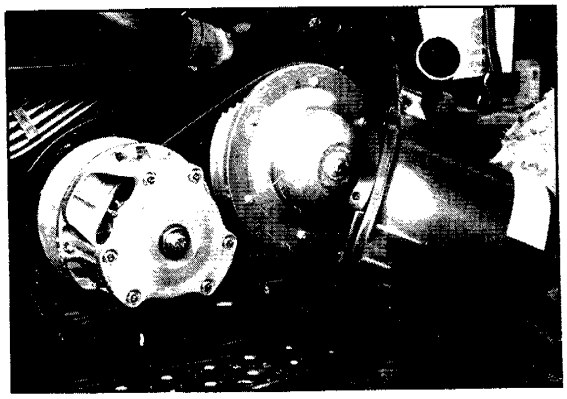
2. Make sure the vent line from the carburetor is routed to the upper part of the frame (B). Check the vent line and be sure it is not pinched or kinked.



3. Install PVT system as outlined in PVT section. Be sure to inspect clutch offset, alignment, and belt deflection and adjust if necessary.



4. Torque drive clutch retaining bolt to 40 ft. lbs. (5.5 kg-m). Torque driven clutch retaining bolt to 17 ft. lbs. (2.35 kg-m).



Assembly

Oil Pump End Play Adjustment

The oil pump is a positive displacement type pump. Whenever the oil pump, oil pump bushing, or crankcase are replaced, the end play clearance must be checked. Target clearance is .008-.024″ (.2-.6mm) between the oil pump boss and the bushing in the crankcase. Symptoms of excessive gear end play include: noticeable engine noise at idle; pump lever arm binds in the 1/2 open position (will release when engine is rotated).

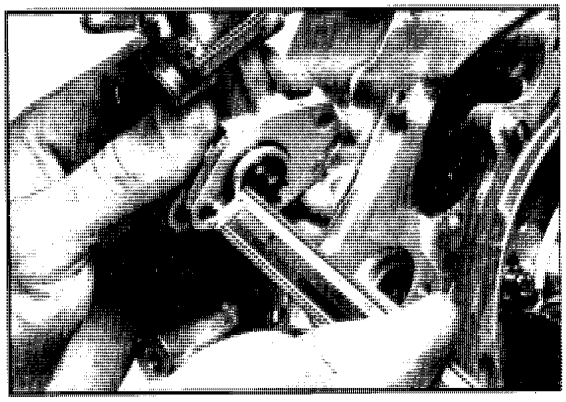
NOTE: Some 250/300 cc ATV engine oil pumps were produced with a plastic oil pump drive gear (PN 3084825). The plastic drive gear is no longer available and subs to a metal drive gear (PN 3083429). If you are replacing a plastic drive gear with a metal one, you must also order and install thrust washer (PN 3083428). If you install the metal drive gear without the thrust washer you will not be able to achieve the proper drive gear end play as outlined below. Refer to the Illustration on page 3.21

250/300 Models

Refer to Illustration on following page.

1. Measure distance from pump shoulder to pump mounting flange. Record this measurement.

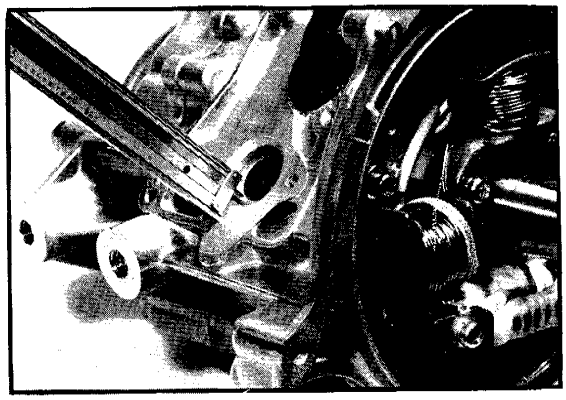
   Example: 3.9mm



2. Lubricate and install pump drive gear thrust washer, pump drive gear, and bushing into crankcase. Make sure parts are completely seated.

3. Measure the distance from the pump bushing to the crankcase pump seating surface. Record this measurement. Example: 4.8mm

4. Subtract the measurement recorded in step 1 from the measurement recorded in step 3. See example below right. The difference between these two measurements is the end play the pump bushings will have without shims. Add shims to adjust end play to .008″ - .024″ (.2 - .6 mm).



EXAMPLE:

	4.8	
–	3.9	
=	.9	
–	.2-.6 mm	Target clearance
=	.3–.7mm	Total thickness of shims required

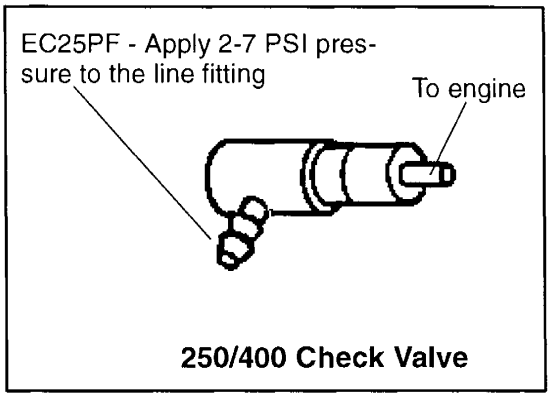
Spacer shim part numbers:

PN 3083671	.15 mm/.006″
PN 3083672	.3 mm/.012″
PN 3083673	.6 mm/.024″

Assembly

Oil Check Valve Testing (250/400)

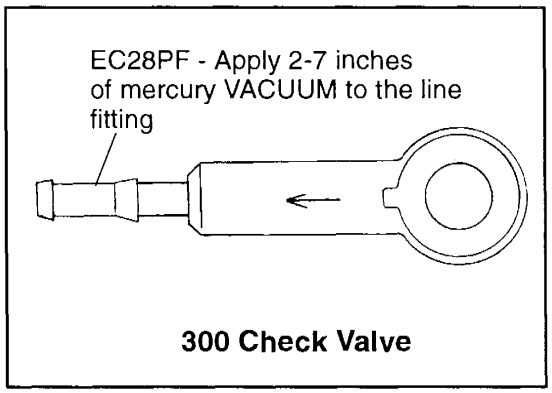
The oil pump check valve on the EC25PF engine must be tested by applying 2-7 PSI of pressure to the line spigot of the check valve. Use a Mity Vac (PN2870975) or similar tester. The valve should release between 2 and 7 PSI. The check valve is located on the cylinder.



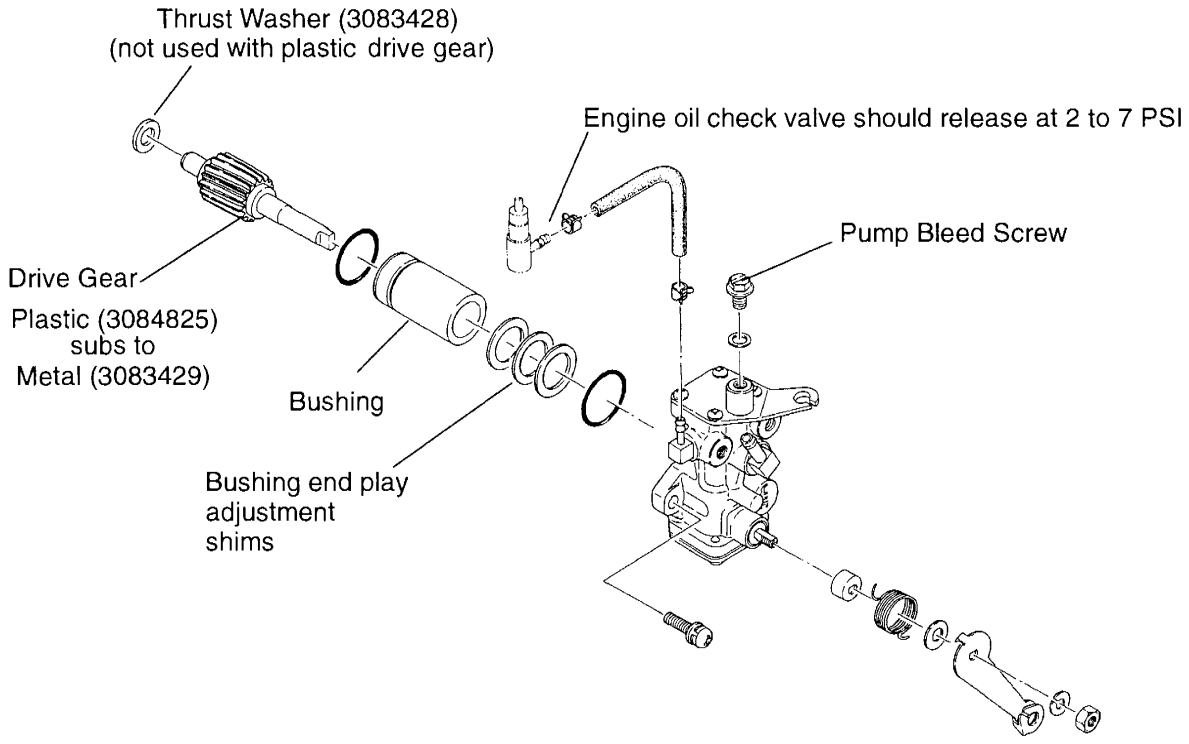
250/400 Check Valve

Oil Check Valve Testing (300)

The oil pump check valve on the EC28PF engine must be tested by applying 3-7 inches of mercury VACUUM to the line spigot of the check valve. The valve should release between 3 and 7 inches of mercury. Use a Mity Vac (PN2870975) or similar vacuum tester. The check valve is located on the oil pump.

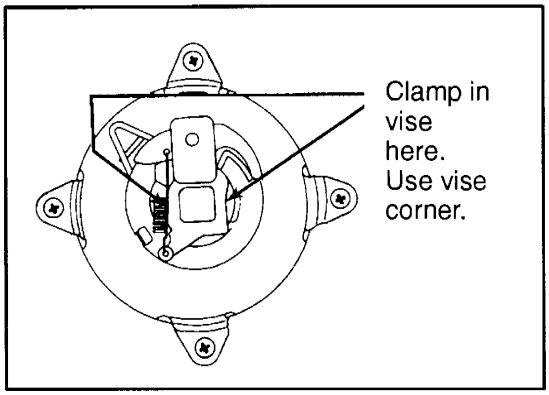


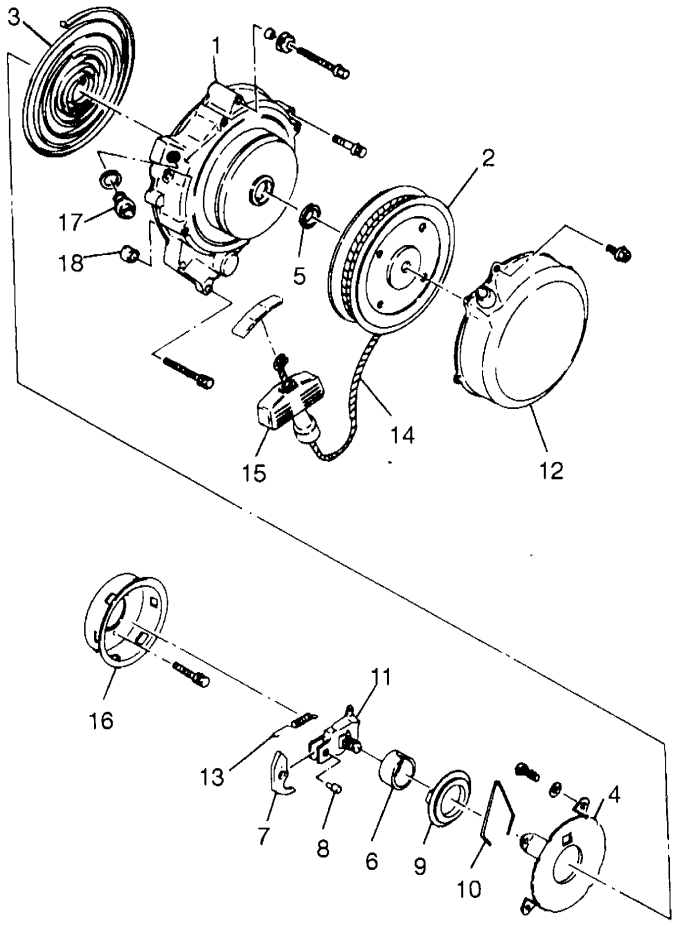
300 Check Valve



Recoil Disassembly

1. Remove four 6mm bolts securing reel housing to flywheel housing. **NOTE:** When the last bolt is removed, the reel housing will rotate, unwinding the recoil spring.
2. Remove reel housing. **NOTE:** If rope replacement is the only service necessary, it may be replaced without any further disassembly.
3. Remove pawl return spring.
4. Clamp sides of ratchet pawl bracket in the corner of the jaws of a vise.
5. Using a cloth belt type strap wrench wrapped around the outside edge of the reel, unscrew the reel counterclockwise to remove it from the ratchet pawl bracket shaft.
6. Remove the ratchet pawl bracket, spring hook, ratchet friction ring and friction spring. **NOTE:** It is not necessary to remove the spring retainer plate and spring unless it is damaged.
7. Clean and inspect all parts. Repair or replace as required.

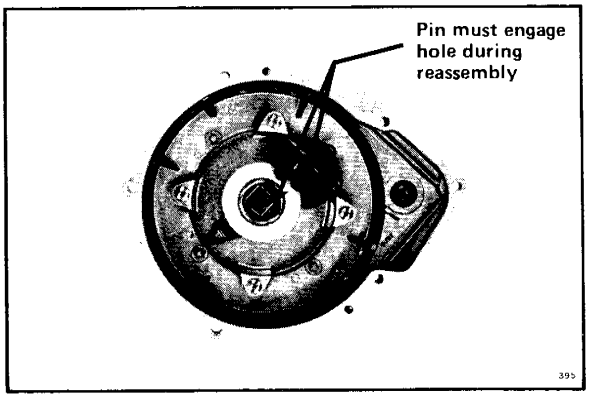




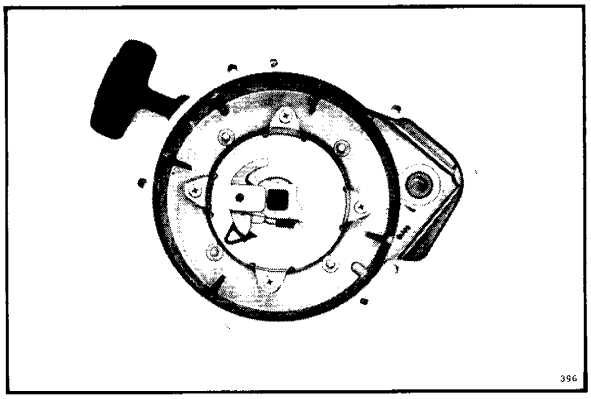
1. Flywheel Housing
2. Reel
3. Recoil Spring
4. Spring Retaining Plate
5. Seal
6. Spring Hook
7. Ratchet Pawl
8. Pawl Pin
9. Ratchet Friction Ring and Pawl Guide
10. Friction Spring
11. Ratchet Pawl Bracket
12. Reel Housing
13. Pawl Return Spring
14. Recoil Rope
15. Rope Handle
16. Recoil Cup
17. Timing Plug
18. Bushing

Recoil Assembly

1. If the recoil spring was removed, reinstall it in its recess in the flywheel housing. The spring should spiral counterclockwise toward the center.
2. Grease spring with Polaris low temperature grease.
3. Install recoil spring retaining plate.
4. Grease and install spring hook, making sure it properly engages the spring end.
5. Install ratchet friction ring and friction spring assembly. The friction spring should engage the bent tab on the recoil spring retaining plate. The "L" on the friction ring should be positioned as shown in the photo at right.
6. Grease the center hole and seal in the flywheel housing.
7. Install ratchet pawl bracket. The alignment pin and the square drive on the bracket shaft should properly align in the spring hook.
8. While holding the bracket tight against the spring hook, flip the flywheel housing over and thread the reel onto the pawl bracket shaft.



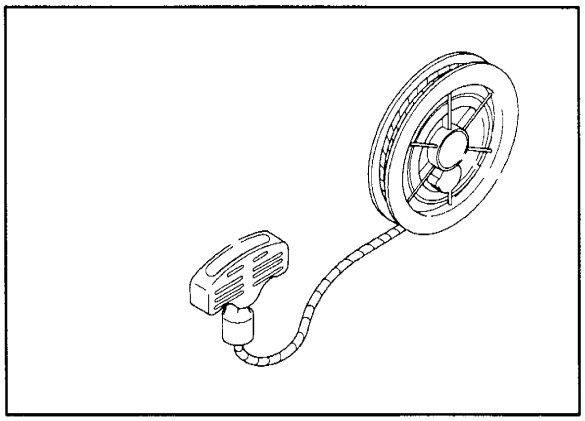
9. Clamp the ratchet pawl bracket in the corner of the jaws of a vise. Firmly hand tighten the reel.
10. If the rope was removed, or if a new rope is being installed, attach one end of the rope to the reel, pass the other end of the rope through the guide in the reel housing and attach it to the rope handle.
11. Install the rope housing over the reel.
12. Holding the flywheel housing with one hand, rotate the rope housing clockwise until the rope is completely re-wound.
13. Rotate the housing three more turns and reinstall bolts.
14. Reinstall pawl return spring.
15. Check recoil and ratchet operation.
16. When reinstalling assembly onto engine, use Loctite 515 Gasket Eliminator between the flywheel housing and crankcase.



Recoil Assembly

The recoil cup is incorporated onto the flywheel.

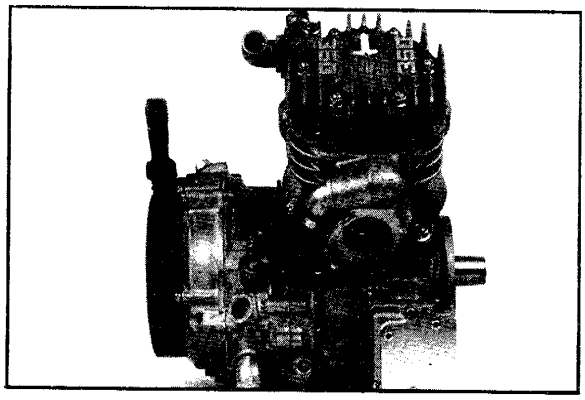
1. If the recoil rope was removed or if a new rope is being installed, attach one end of the rope to the reel, pass the other end of the rope through the guide in the reel housing and attach it to the rope handle.
2. Install the rope housing over the reel.
3. Holding the flywheel housing with one hand, rotate the rope housing clockwise until the rope is completely re-wound.
4. Rotate the housing three more turns and install the pawl return spring with the large end of the spring going into rope housing; reinstall retainer plate, lock washer and bolt.
5. Check recoil and ratchet operation.
6. When reinstalling assembly onto engine, use Loctite 515 Gasket Eliminator between the flywheel housing and crankcase.



Disassembly

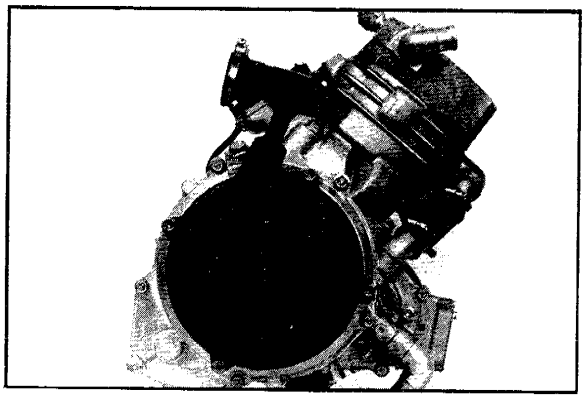
NOTE: To reassemble engine, reverse the following procedure, paying attention to reassembly notes as indicated.

1. Refer to page 3.8 and follow engine removal instructions. This engine will also require removal of coolant lines and the sending unit wire mounted at the rear of the cylinder head.



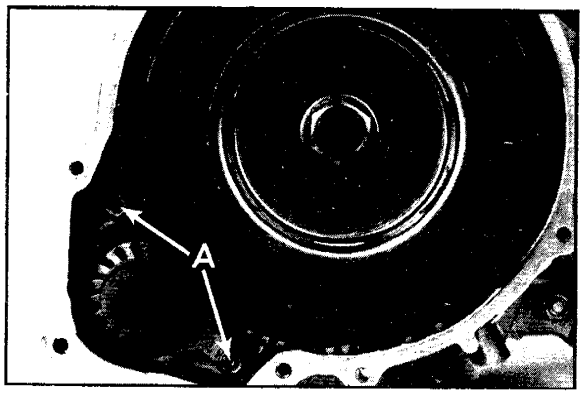
2. Remove the six bolts retaining the starter assembly and flywheel cover.

Reassembly Note: During reassembly apply Loctite 518 to mating surfaces of starter cover assembly and crankcase assembly.

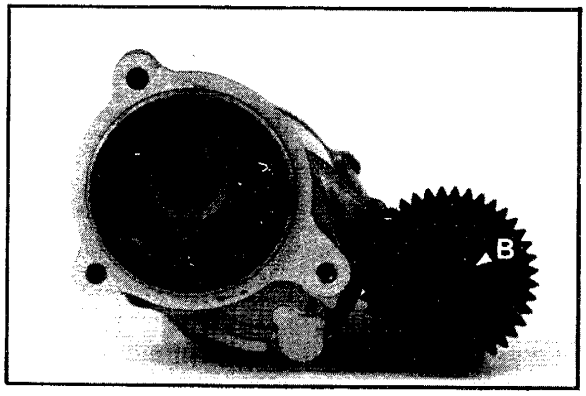


3. Remove starter pulley and flywheel nut.

4. For starter removal, remove bolts retaining starter bracket on PTO side and two bolts (A) on mag side.

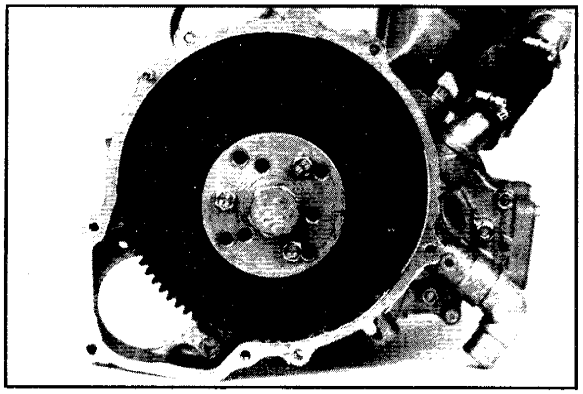


NOTE: If starter inspection is necessary, make sure during reassembly that the gear shaft washer (B) is in place between the gear shaft assembly and starter motor for reassembly. Starter damage will occur if this washer is not correctly positioned. For detailed service and repair of electric starters and starter drives, refer to Chapter 8 of this Service Manual.



7. Remove flywheel using Polaris flywheel puller .

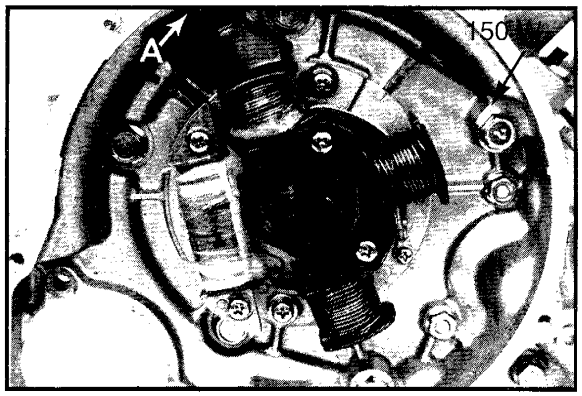
Flywheel Puller PN 2871043



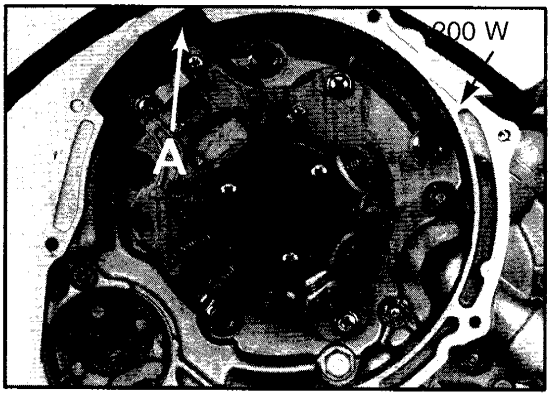
8. Remove stator assembly.

Reassembly Note: During reassembly be sure to seal rubber grommet (A) completely with silicone sealer to avoid water or dirt ingestion into stator assembly.

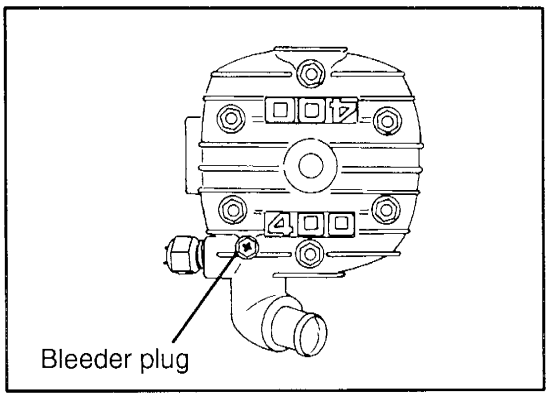
150 Watt alternator shown at right (photo 2).



200 Watt alternator shown at right (photo 3).

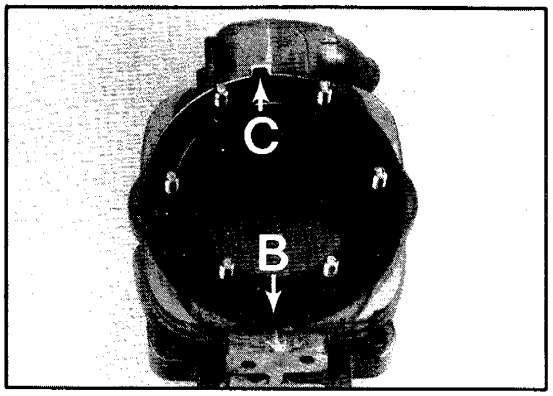


9. Remove six cylinder head bolts using a 12 mm socket. Note the position of the bleeder plug for the coolant system.



Disassembly, Cont.

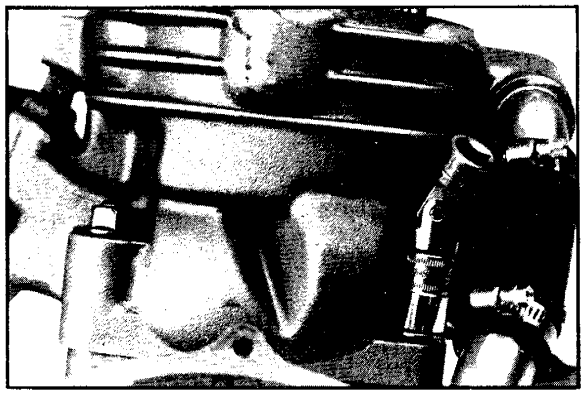
400L Head Gasket pictured at right.



Reassembly Note: The 400L head gasket should have the word *UP* (B) toward the cylinder head and the tab (C) toward the exhaust, matching the tab area on the cylinder.

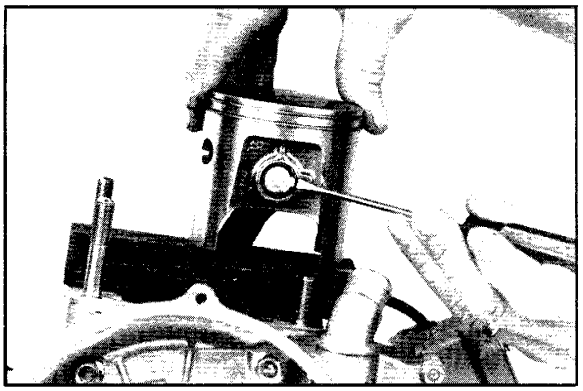
NOTE: Small hole in cylinder above exhaust port is a decompression aid for starting.

10. Loosen clamps retaining coolant transfer hose and remove the four cylinder nuts. **NOTE:** Use a 14 mm socket on the exhaust side. A 14 mm wrench will be necessary on the intake side.



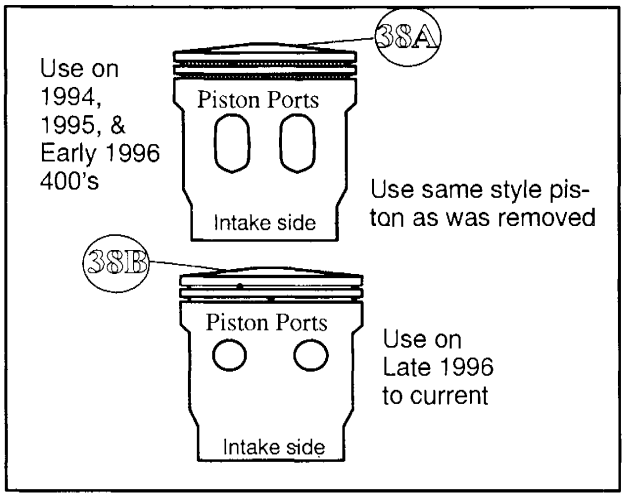
Reassembly Note: Due to limited space you will need to use a crows foot adaptor for final torquing during reassembly.

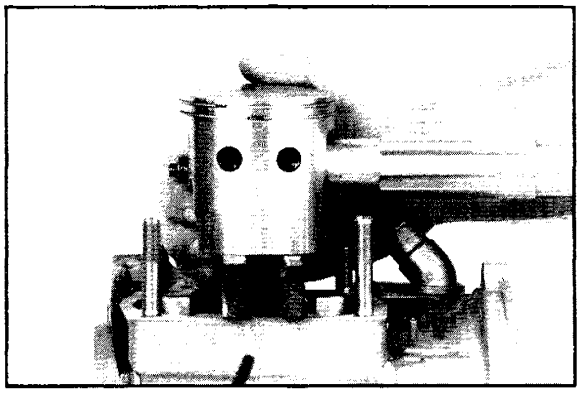
11. Install piston support block and remove C clips.



Reassembly Note: When reinstalling C clips, make sure that the open end of the retainer clip points either up or down, not to the side.

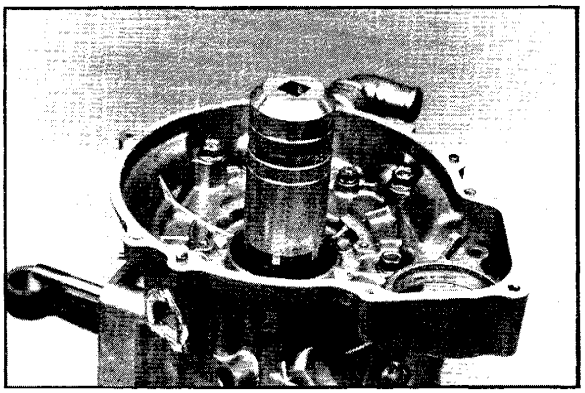
12. Remove piston pin using Polaris piston pin puller (PN 2870386).



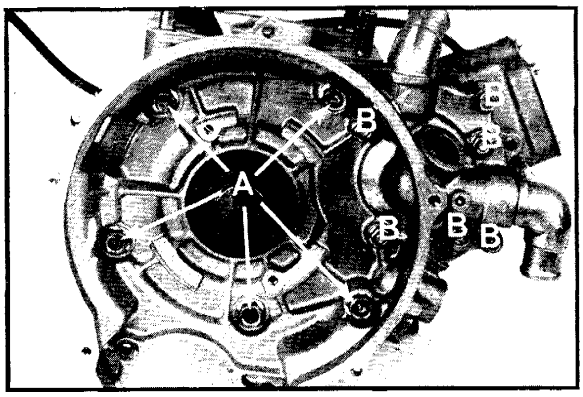


13. Remove slotted *left hand thread* crankshaft nut using Polaris tool (PN 2870967).

Reassembly Note: Reinstallation of this crankshaft nut will also require use of tool PN 2870967.

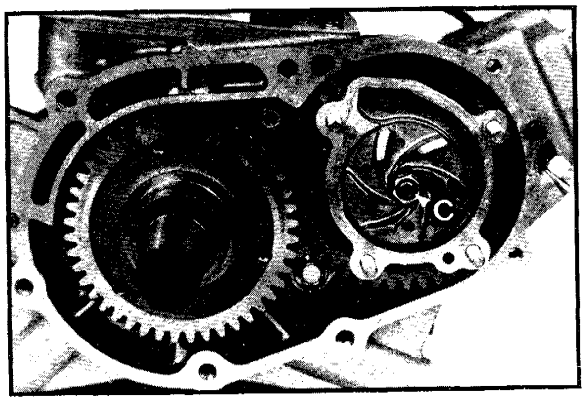


14. Remove five crankcase bolts (A) with a 12 mm socket.
15. Remove four nuts and two bolts (B) indicated in the photo at right with a 10 mm socket.
16. Remove cover, tapping lightly with a soft face hammer if necessary.



17. Using a 10 mm socket, remove the impeller nut (C).
18. Slide water pump assembly from counterbalance assembly.

Reassembly Note: Watch for adjuster shims which may be between the impeller and pump housing. Make sure to reinstall any shims removed. Apply Loctite 242™ to impeller nut.

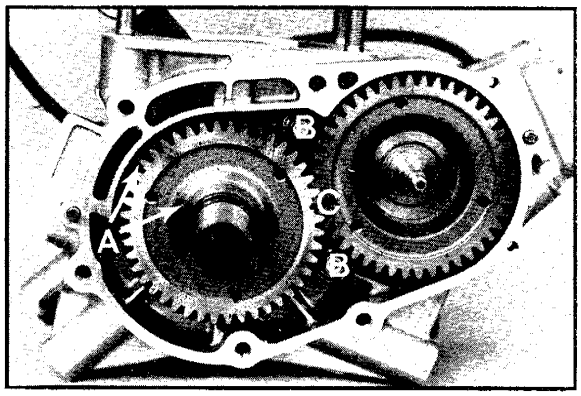


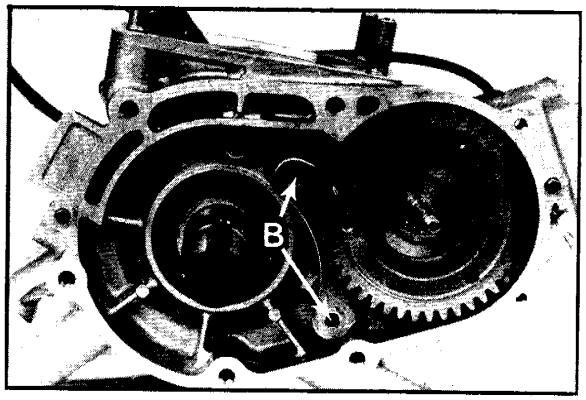
Disassembly, Cont.

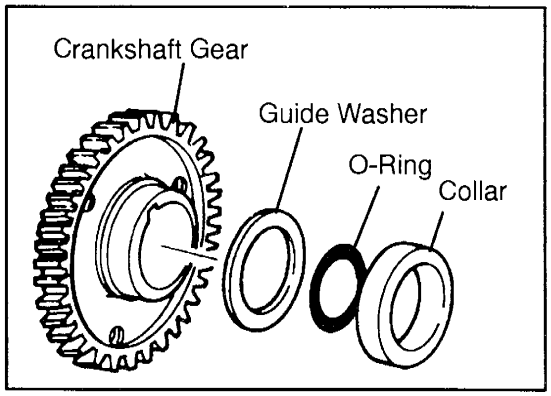
17. Remove collar, O-ring, guide washer and crankshaft gear (A). **NOTE:** A large screwdriver may be used to aid removal.

18. Remove two bolts retaining the counter balance bracket (B) using a 10 mm socket. **CAUTION:** Make no attempt to remove the counterbalance until steps 17 and 18 are complete, or damage may result to the counterbalance assembly.

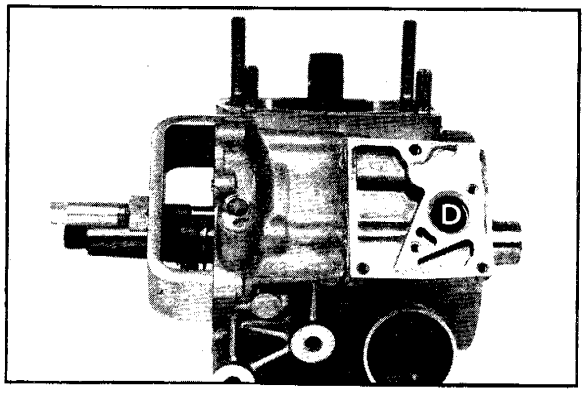
Reassembly Note: Punch marks (C) on both gears must be across from each other during reassembly. See photo three at right.







19. Remove oil pump assembly (D).

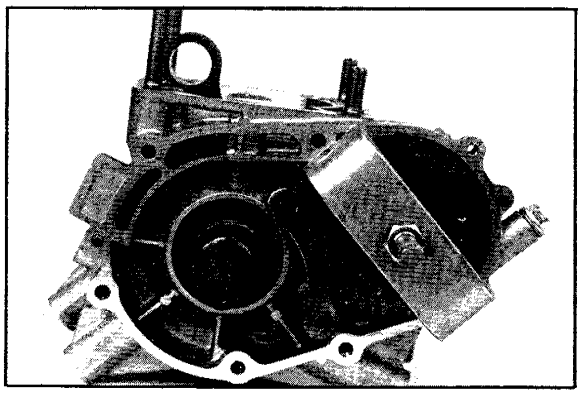


20. Attach counterbalance puller onto counter balance and position as shown in the picture at right.

Reassembly Note: The retainer bracket must be in position on the counterbalance assembly before the assembly is installed in the crankcase.

Counter Balance Puller

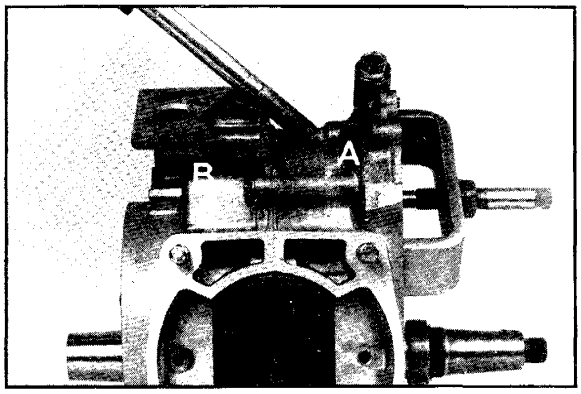
PN 2870968



Disassembly, Cont.

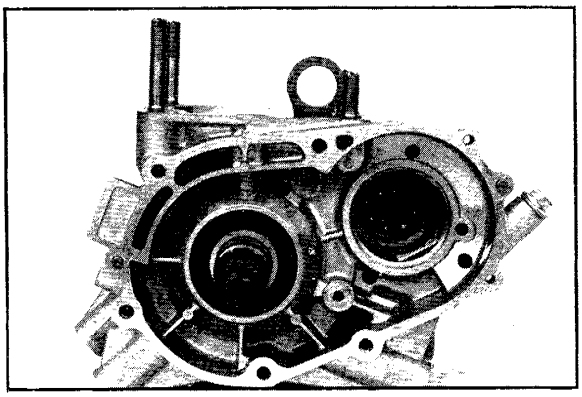
21. Heat areas (A) and (B) with a small propane torch for approximately one to two minutes, no closer than 1″ (2.5 cm) from case areas.

WARNING: Oil and gasoline are highly flammable and explosive under certain conditions. Use extreme caution when using a propane torch in this environment.



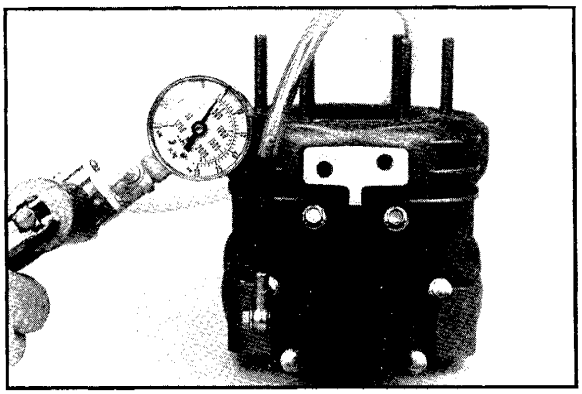
22. Once these areas are thoroughly heated, add tension to the puller by turning the large nut. Continue tensioning the puller until the counterbalance assembly is completely removed.

Reassembly Note: For reassembly of counterbalancer, heat areas (A) and (B) and press the balancer and bracket back into place.

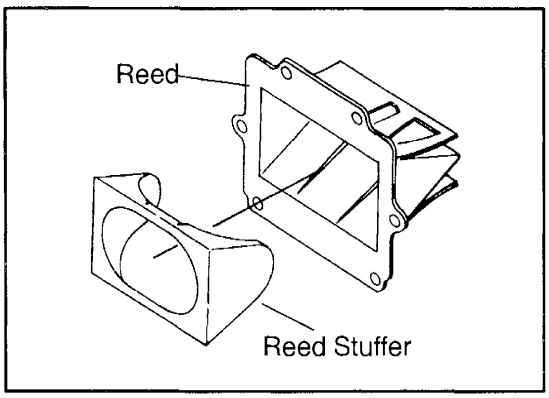


23. With counterbalance assembly removed, follow instructions for crankshaft service on pages 3.13 - 3.15.

24. The injection oil check valve is tested using the Mity Vac™ (PN 2870975). With the Mity Vac in the pressure mode the check valve should release between 2 and 5 PSI.



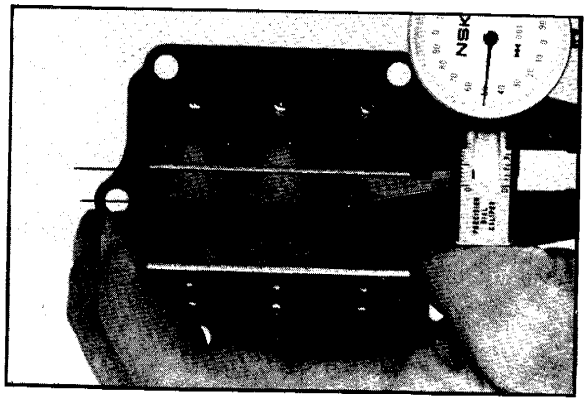
25. Remove the six bolts retaining the carb adapter and reed valve assembly using an 8 mm socket. **NOTE:** The reed stuffer is standard on the 400L models.



Disassembly, Cont.

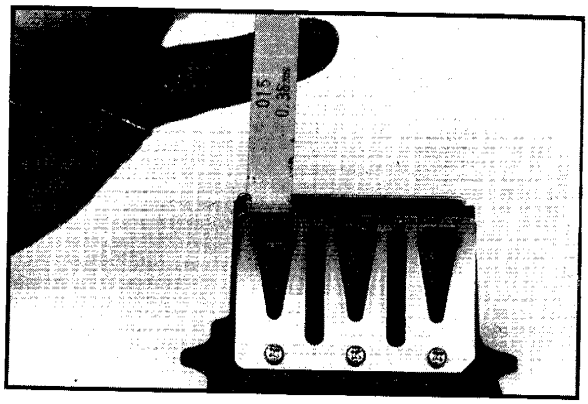
Reed Valve Assembly

26. Measure reed stop height in the area (A) indicated. Recommended stop height is .350″ (9 mm).



27. Measure the air gap of each reed valve petal as shown in the photo at right. The air gap should not exceed .015″ (.4 mm). **NOTE:** An early sign of reed valve failure may be hard starting.

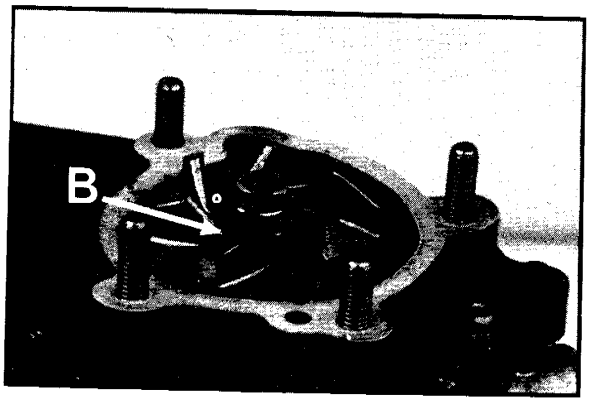
28. Check each reed valve petal for white stress marks or missing material. Replace if necessary.



Water Pump Impeller Clearance

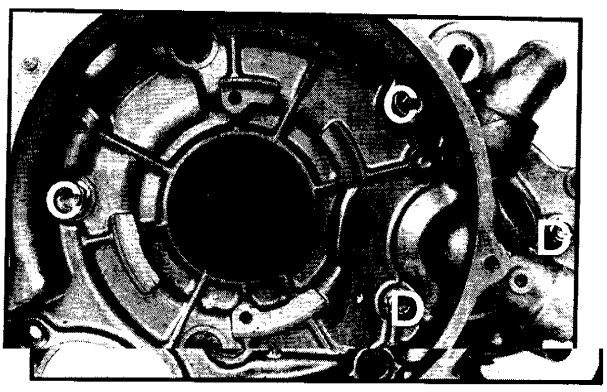
Whenever the counterbalance assembly is removed it will be necessary to verify impeller clearance. Following is a recommended procedure for measuring water pump impeller clearance.

29. Apply a small amount of putty or clay to the top of one impeller blade (B).



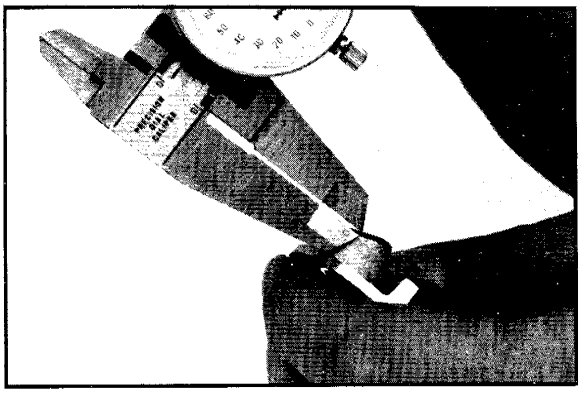
30. Reinstall case gasket and bolt case together at areas (C) and (D) as indicated on the photo at right.

31. Carefully remove case cover.

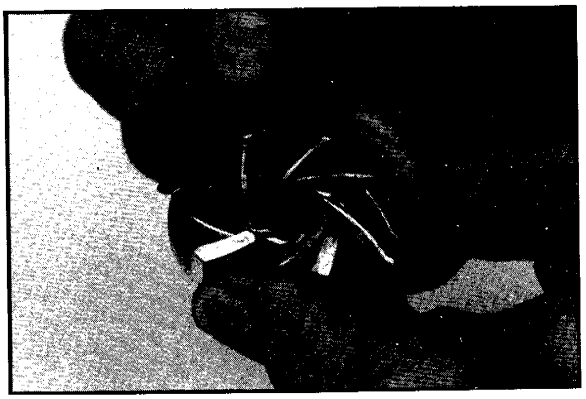


Disassembly, Cont.

5. Remove water pump impeller and check clearance measurement. Acceptable clearance measured with a dial caliper is between .020″ - .040″ (.05 -.1 cm). **CAUTION:** If the clearance is less than .020″ (.05 cm) the impeller may grind against the case. If the clearance is more than .040″ (.1 cm) the water pump may cavitate.



6. The photo at right illustrates checking clearance measurement with a feeler gauge. This method may also be used to check thickness by removing half of the putty from the impeller blade.



Spacer shim part numbers:

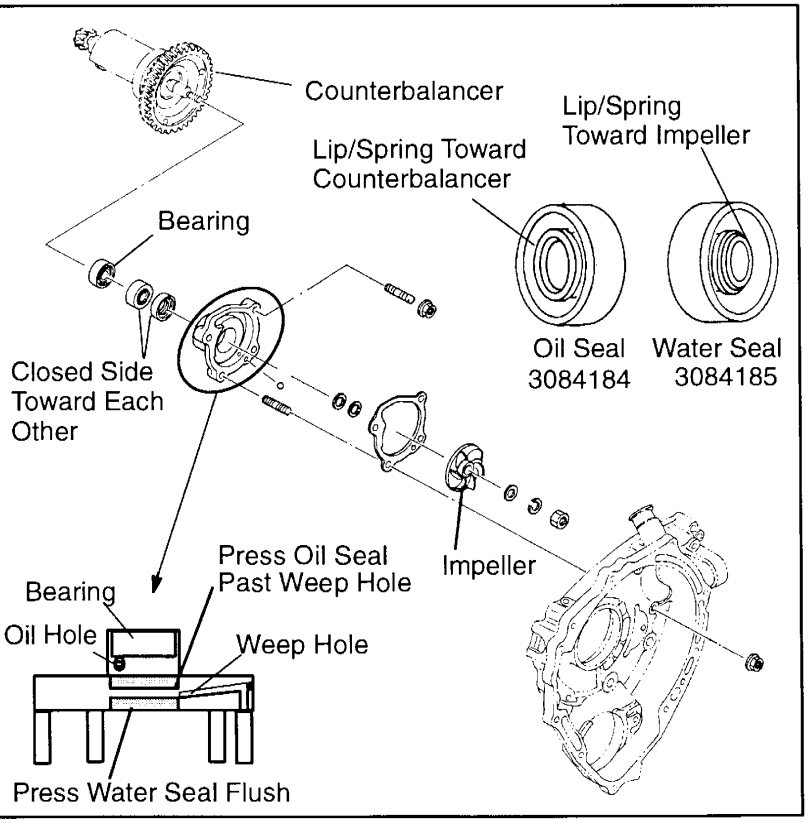
PN 3084188 0.1 mm/.004″

PN 3084189 0.2 mm/.008″

The illustration depicts correct positioning of the seals. The water seal is identified by counting the number of sealing "lips". It is a triple lip seal and has a protruding edge that faces away from the spring.

The oil seal is a double lip variety. The lip (on the spring end) angles back toward the spring. The spring end of the seals (open side) must face the oil or coolant as shown in the illustration.

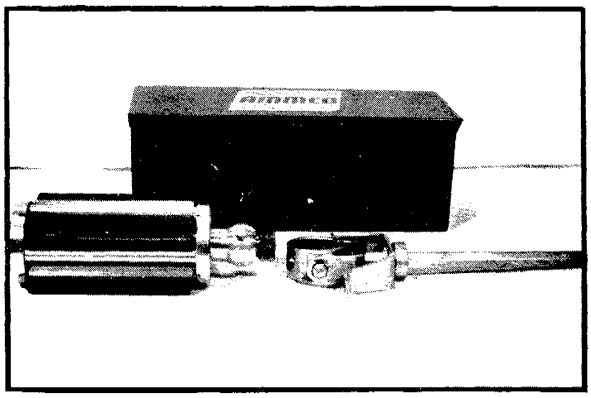
To assemble the pump casing, press the bearing into the casing until *flush* with the casting. Note: *Do not* press the bearing in until it seats against the shoulder, or the oil hole will be covered by the bearing outer race. Next, press the oil seal into the seal bore until the weep hole is visible. Now press the water seal in until flush with the outer edge of the seal bore.



Cylinder Hone Selection/Honing Procedure

Selecting a hone which will straighten as well as remove material from the cylinder is very important. Using a common spring loaded finger type glaze breaker for honing is never advised. Polaris recommends using a rigid type hone which also has the capability of oversizing. Two manufacturers of this type of hone are Sunnen Products Company of St. Louis, Missouri and Ammco Tools, Inc., of North Chicago, Illinois.

The photo at right shows the Ammco No. 3950 hone.

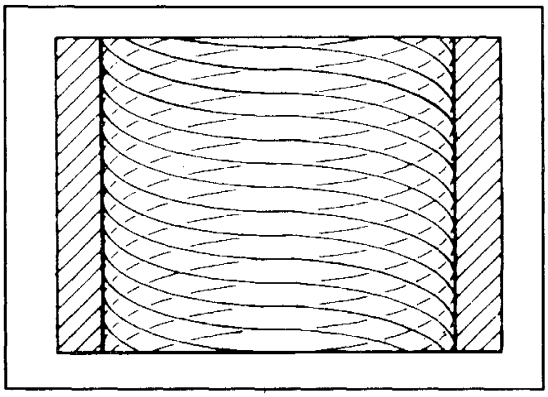


Cylinders may be wet or dry honed depending upon the hone manufacturer's recommendations. Wet honing removes more material faster and leaves a more distinct pattern in the bore.

CAUTION:

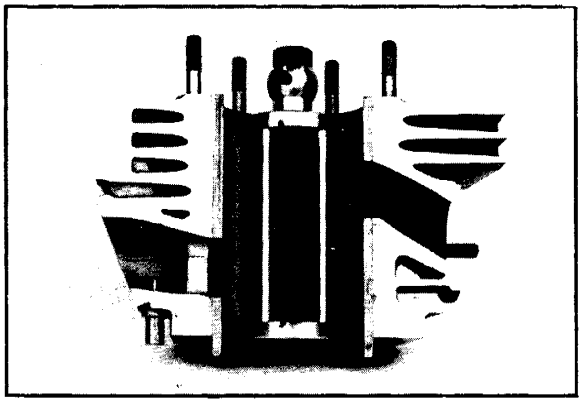
It is important that the cylinder be thoroughly cleaned after honing to remove all grindings which could cause piston or cylinder damage. Wash the cylinder in a solvent; then in hot soapy water; rinse; blow dry; and oil lightly.

NOTE: Honing material may become trapped in rough casting areas such as the area between the cylinder sleeve and port openings. Use electrical contact cleaner to ensure these areas are clean.

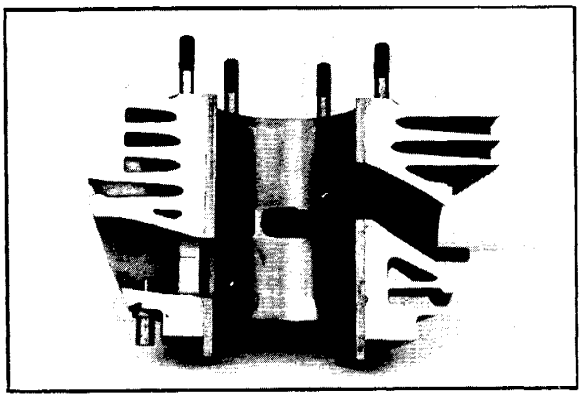


A finished cylinder should have a cross-hatch pattern to aid in the retention of the fuel/oil mixture in the initial break in.

1. Wash cylinder with solvent.
2. Using a vise, clamp cylinder around the exhaust port studs. **NOTE:** Protect from vise jaw serrations with brass stock, wood or cardboard.
3. Place hone in cylinder. Tighten stone adjusting knob until the stone contacts the cylinder walls. **CAUTION:** Do not overtighten. Cylinder damage may result.
4. With a 1/2″ drill motor at a speed of 300-500 RPM, run the hone in and out of the cylinder rapidly until cutting tension decreases. Remember to keep the hone drive shaft centered and to bring the stone approximately 1/2″ (1.3 cm) beyond the bore at the end of each stroke.



5. Release the hone at regular intervals and inspect the bore to determine if it has been cleared, and to check piston fit. **NOTE:** Don't allow cylinder to heat up during honing. The thinner areas of the liner around the ports will expand causing uneven bore.
6. After honing has been completed inspect all port opening areas for rough or sharp edges. Apply a slight chamfer to all ports to remove sharp edges or burrs, paying particular attention to the corners of the intake and exhaust ports.



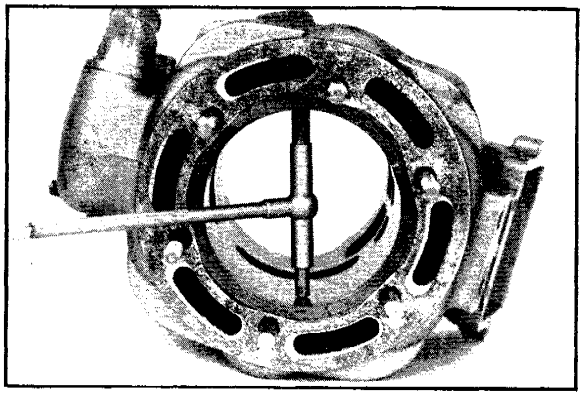
Piston/Cylinder Clearance (2 Strokes)

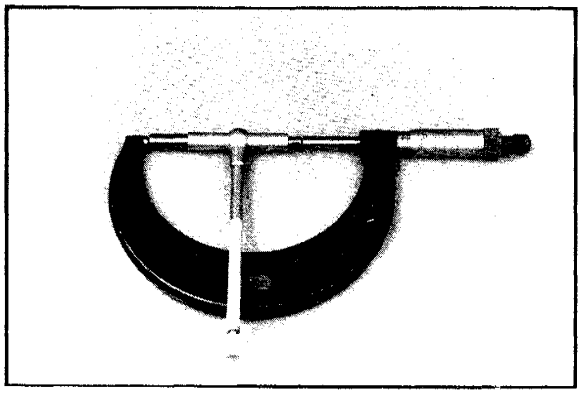
CAUTION:

Follow new engine break-in procedures after replacing piston/rings. Pre-mix the first tank of fuel. Bleed oil pump and warm engine thoroughly. Avoid sustained full throttle for the first two tanks of fuel. Confirm oil system is working properly. Oil level in reservoir should drop after first tank of fuel.

Cylinder Inspection/Measurement

Inspect cylinder for wear, scratches, or damage. If no damage is evident, measure cylinder for taper and out of round with a telescoping gauge and micrometer or a dial bore gauge. Measure bore 1/2″ down from top of cylinder in two directions - in line with piston pin and 90° to the pin to determine if bore is out of round. Repeat measurements at bottom of cylinder to determine taper or out of round at the bottom. Record all measurements.



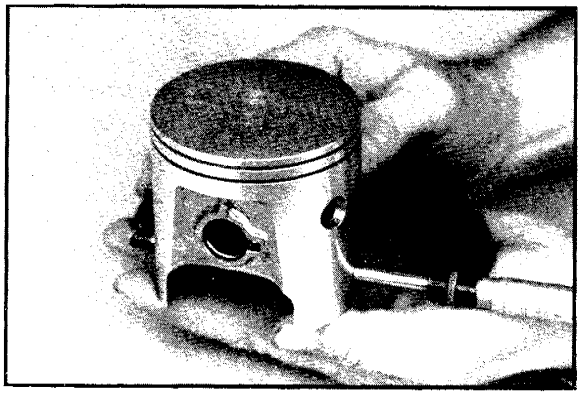


Piston Inspection/Measurement (Generic)

1. Check piston for scoring or cracks in piston crown or pin area. Excessive carbon buildup below the ring lands is an indication of piston, ring or cylinder wear.
2. Measure piston outside diameter at a point 10 mm (3/8″) up from bottom of skirt at a 90° angle to the direction of the piston pin. Record the measurement.

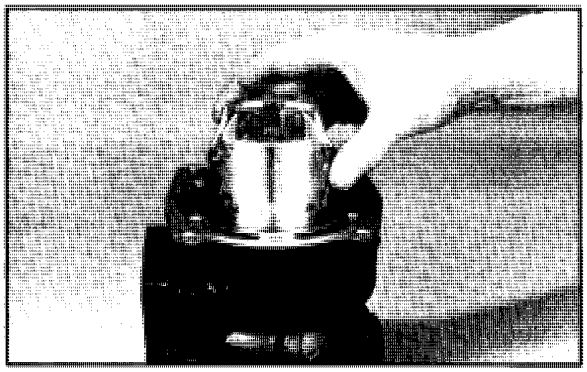
NOTE: The piston must be measured at this point to provide accurate piston-to-cylinder clearance measurement.

3. Subtract this measurement from the maximum cylinder measurement recorded previously. If clearance exceeds the service limit, determine if piston or cylinder is worn and recondition or replace as necessary. Refer to page 3.3 for piston to cylinder clearance specifications.



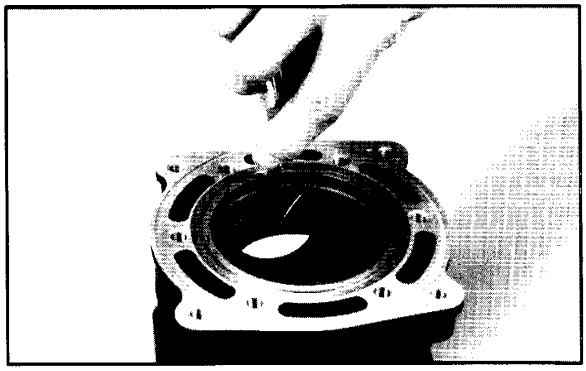
Piston Ring Installed Gap

1. Position each piston ring 1/2" (1.3 cm) from the top of the cylinder using the piston to push it squarely into place. Measure installed gap with a feeler gauge at both the top and bottom of the cylinder.



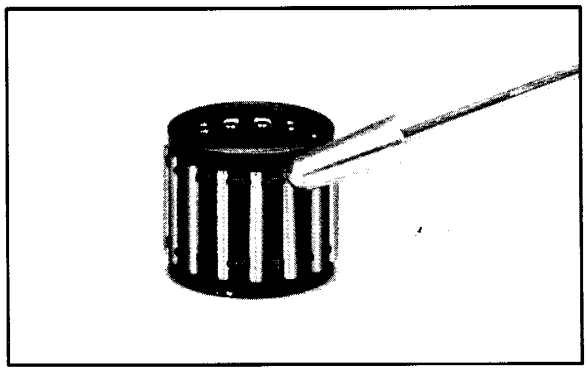
NOTE: A difference in end gap between the bottom and top of the cylinder indicates cylinder taper. The cylinder should be measured for excessive taper and out of round. Replace rings if the installed end gap exceeds the service limit. Refer to page 3.3 for specifications.

NOTE: Always check piston ring installed gap after re-boring a cylinder or when installing new rings.

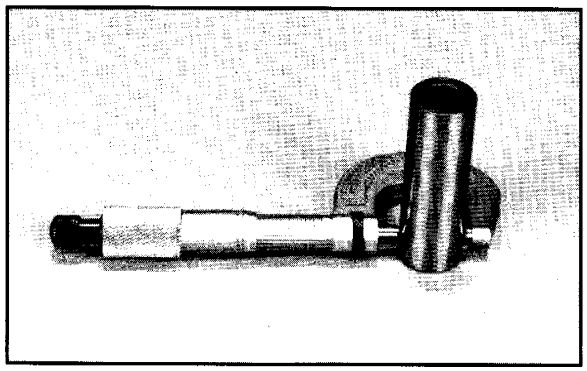


Piston Pin / Needle Bearing Inspection

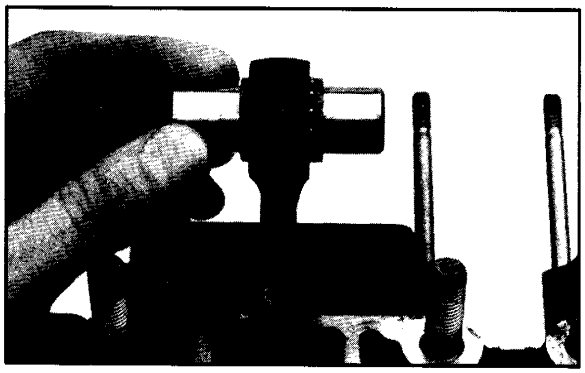
1. Clean needle bearing in solvent and dry with compressed air.
2. Inspect needle cage carefully for cracks or shiny spots which indicate wear. Replace needle bearing if worn or cracked, and always replace if piston damage has occurred.



3. Visually inspect piston pin for damage, discoloration, or wear. Run your fingernail along the length of the pin and replace it if any rough spots, galling or wear is detected. Measure piston pin.

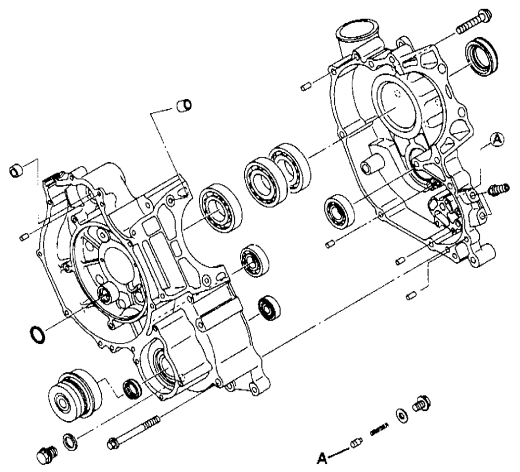


Connecting Rod Small End Inspection

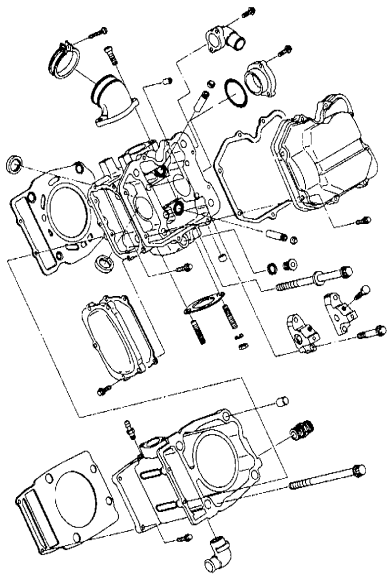


1. Clean small end of connecting rod and inspect inner bore with a magnifying glass. Look for any surface irregularities including pitting, wear, or dents.
2. Run your fingernail around the inside of the rod and check for rough spots, galling, or wear.
3. Oil and install needle bearing and pin in connecting rod. Rotate pin slowly and check for rough spots or any resistance to movement. Slide pin back and forth through bearing while rotating and check for rough spots.
4. With pin and bearing centered in rod, twist ends back and forth in all directions to check for excessive axial play. Pull up and down evenly on both ends of pin to check for radial play. Replace pin *and* bearing if there is any resistance to rotation or excessive axial or radial movement. If play or roughness is evident with a new pin and bearing, replace the connecting rod.

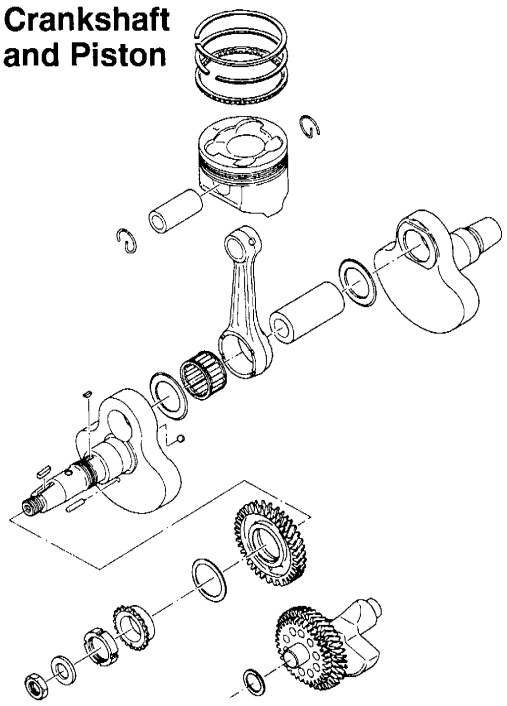
Crankcase



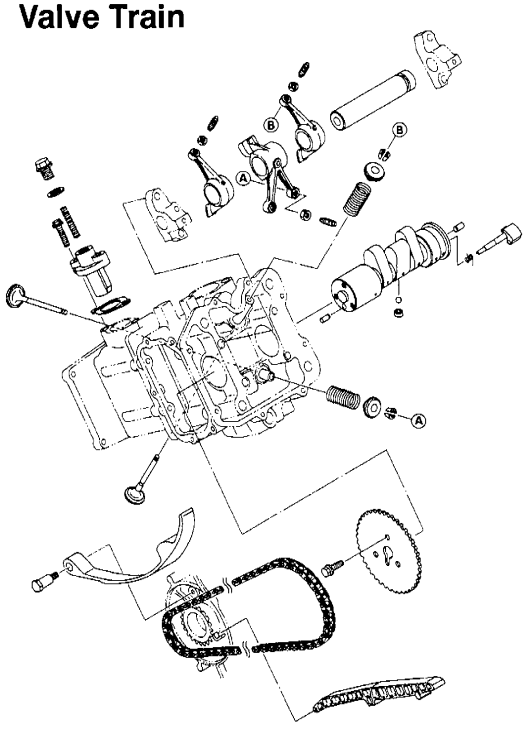
Cylinder/ Cylinder Head



Crankshaft and Piston



Valve Train



Engine Lubrication

Oil Type	Polaris Premium 4 Synthetic (PN 2871281); or API certified "SH" 5W30 oil
Capacity	2 U.S. Quarts (1.9 l)
Filter	PN 3084963
Filter Wrench	Snap On PN YA997 or equivalent
Drain Plug Torques	14 ft. lbs. (1.9 kg-m) tank and sump
Oil Pressure Specification	20 PSI @ 5500 RPM, Polaris 0W/40 Synthetic (Engine Hot)

Oil Flow

The chart on page 3.37 describes the flow of oil through the engine. Beginning at the oil tank, the oil flows through a screen fitting in the bottom of the tank and into the oil supply hose. The feed side of the oil pump draws oil through the hose and into the crankcase oil gallery, and then pumps the oil through another passage to the one way valve. (When the engine is off, the one way valve closes to prevent oil in the tank from draining into the crankcase.) The oil is pumped through a delivery pipe to the oil filter. If the oil filter is obstructed, a bypass valve contained in the filter allows oil to bypass the filter element.

At this point, the oil is diverted in two directions. Oil is supplied to the camshaft through the left front cylinder stud, and an oil passage in the head. Oil enters the camshaft through the PTO (L) journal. The camshaft journals, cam lobes, and rocker arms are lubricated through holes in the camshaft. The oil lubricates the cam chain and sprocket and drains to the sump.

The other oil path from the filter leads through a delivery pipe to the crankcase main oil gallery, which leads to the stator plate oil passage. Here it passes through the slotted friction bearing into the crankshaft. An oil seal on the stator plate prevents oil from entering the stator/flywheel area. Oil travels through the crankshaft to the crank pin, lubricating the connecting rod large end bearing directly. Oil also passes through an oil jet (drilled orifice) in the end of the crank pin to the PTO end main bearings and counterbalancer gears.

Residual oil from the lubrication of the crankshaft and connecting rod indirectly lubricates the cylinder wall, piston, rings, connecting rod small end bearing, piston pin, oil/water pump drive gears, cam chain and drive sprocket, and Magneto end crankshaft main bearing.

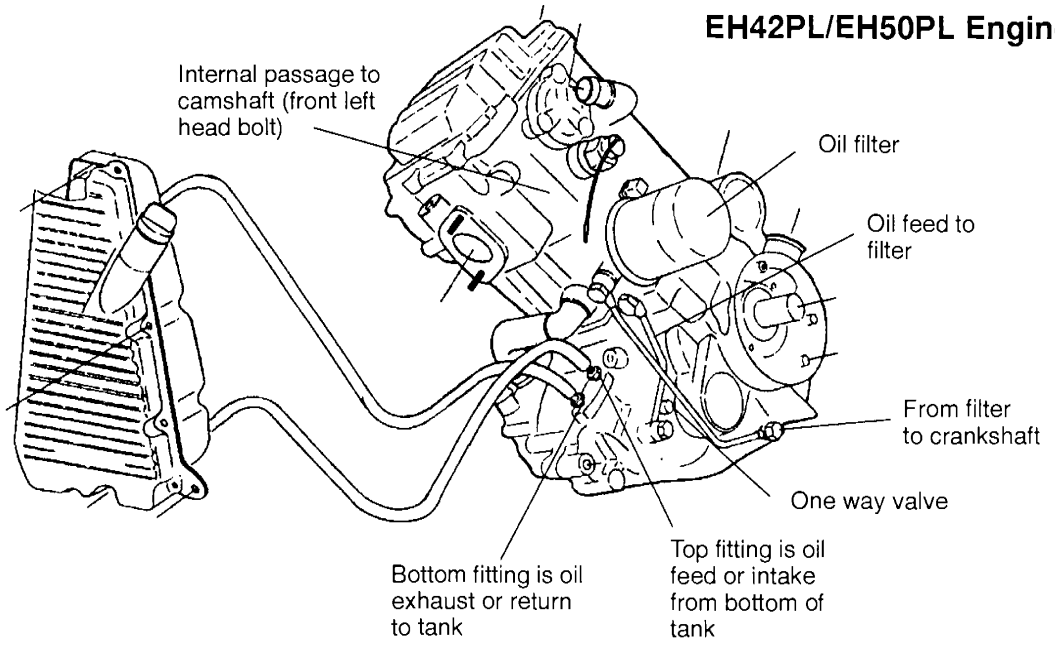
The one-way valve is located on the front left (PTO) side of the crankcase. The valve prevents oil in the tank from draining into the engine sump when the engine is off. The valve mechanism consists of a plunger, return spring, guide plug, and sealing washer. When the engine is running, oil pressure lifts the plunger off the seat, allowing oil flow. When the engine is off, spring pressure forces the plunger against the oil passage seat, preventing oil flow from the tank to the sump. The one-way valve requires very little maintenance. If engine oil drains into the sump when the engine is off, inspect the valve sealing surface for debris or damage. Inspect the return spring for distortion or damage.

Oil Pressure Test

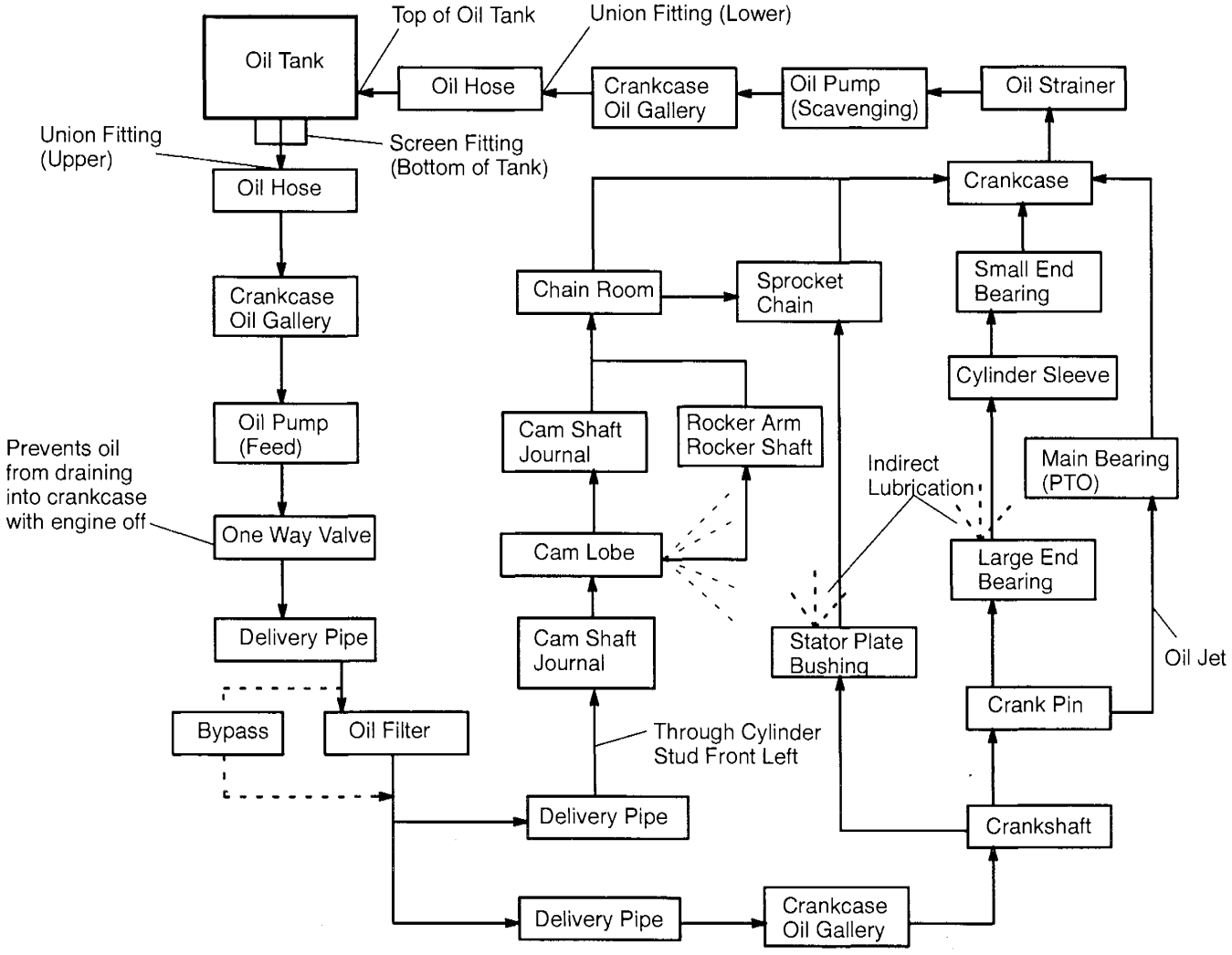
1. Remove blind plug on front left cylinder head.
2. Insert a 1/8 NPT oil pressure gauge adaptor into the cylinder head and attach the gauge.
3. Start engine and allow it to reach operating temperature, monitoring gauge indicator.

Oil Pressure at 5500 RPM (Engine Hot):
Standard: 20 PSI
Minimum: 12 PSI

EH42PL/EH50PL Engine


Internal passage to camshaft (front left head bolt)
Oil filter
Oil feed to filter
From filter to crankshaft
One way valve
Top fitting is oil feed or intake from bottom of tank
Bottom fitting is oil exhaust or return to tank

EH42PL/EH50PL Oil Flow Chart



Removal

The following components can be serviced or removed with the engine installed in the frame:

- PVT System
- Flywheel
- Alternator/Stator
- Starter Motor/Starter Drive
- Camshaft
- Rocker Arms
- Cam Chain and Sprockets
- Cam Chain Tensioner and Guides
- Cylinder Head
- Cylinder
- Piston/Rings

The following components require engine removal for service:

- Oil Pump
- Water Pump*
- Water Pump Mechanical Seal
- Counterbalancer Assembly
- Connecting Rod
- Crankshaft
- Crankshaft Main Bearings
- Crankcase

* Complete engine removal is not necessary to inspect or replace the water pump impeller.

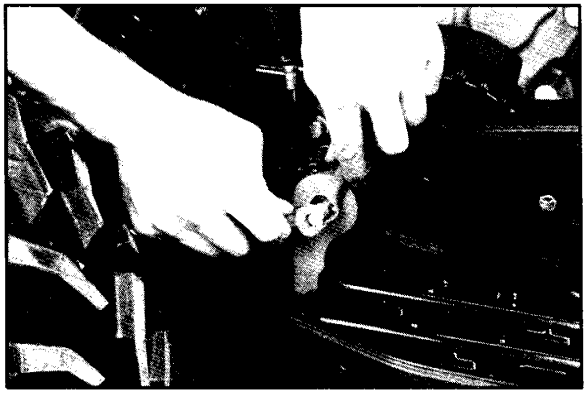
Engine Removal Preparation

1. Clean work area.
2. Thoroughly clean the ATV engine and chassis.
3. Disconnect battery negative (-) cable.
4. Drain oil tank and engine sump.
5. Remove the following parts. Refer to the Body Chapter for removal procedures.
   - Seat
   - Left and Right Side Covers
   - Fuel Tank Cover
   - Fuel Tank (see Fuel System Chapter)
   - Rear Rack
   - Rear Cab
6. Disconnect spark plug high tension lead.
7. Remove air pre-cleaner and duct.
8. Disconnect engine breather line from engine.
9. Hold plastic fitting on airbox LH side with a wrench, remove oil tank breather line clamp and remove line.
10. Loosen carburetor boot clamp and two bolts securing airbox. Remove airbox.

Removal, Cont.

11. Remove carburetor.
12. Insert a shop towel into the carburetor flange to prevent dirt from entering the intake port.
13. Remove springs from exhaust pipe and remove pipe.

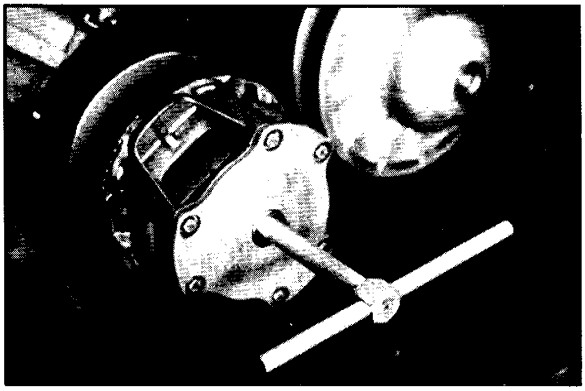
AWD Models:



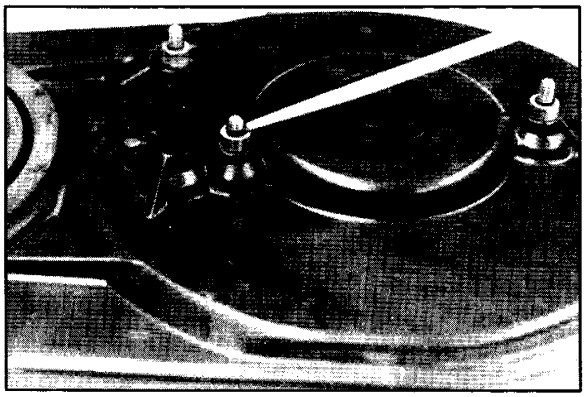
14. Loosen auxiliary brake adjuster locknut, remove adjusting bolt and brake actuator arm.
15. Remove center chain guard bolt, two screws, and chain guard.
16. Remove center drive and driven sprocket bolts and remove chain and sprockets as an assembly.

PVT Disassembly, All Models:

1. Remove the screws and retainer clips from PVT outer cover and remove cover.
2. Mark the drive belt direction of rotation and remove drive belt. The belt is normally installed so the numbers can be easily read.



3. Remove drive clutch retaining bolt and remove drive clutch using puller PN 2870506.
4. Remove driven clutch retaining bolt and driven clutch using puller PN 2870913.
5. Remove driven clutch offset spacers from the transmission input shaft.
6. Remove cable tie from PVT air outlet duct.
7. Bend back retainer tabs on three screws at the front of the inner cover and remove screws and retainer plate.
8. Loosen three inner cover retaining bolts at the rear of the cover only enough to allow cover removal.



9. Remove cover. **NOTE:** Do not lose spacers or spacer retaining O-rings located on the inside of the inner cover.

Removal, Cont.

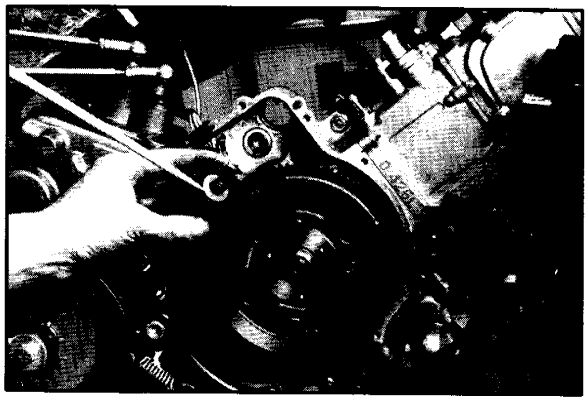
Recoil/Stator Removal

NOTE: Removal of the recoil flywheel and stator assembly will allow additional clearance for engine removal.

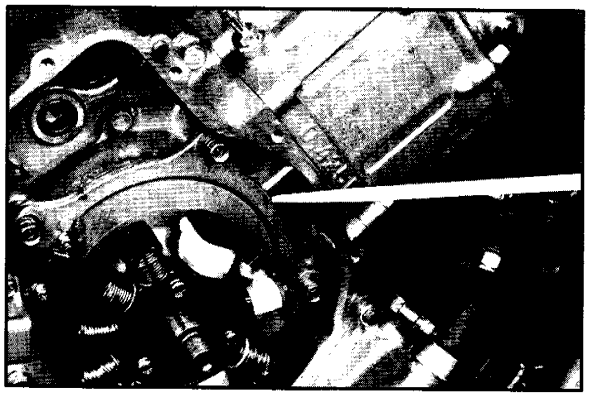
Remove:

- Recoil housing bolts and housing.
- Starter drive assembly. Note the thrust washer located at the rear of the drive mechanism.
- Flywheel nut and washer.

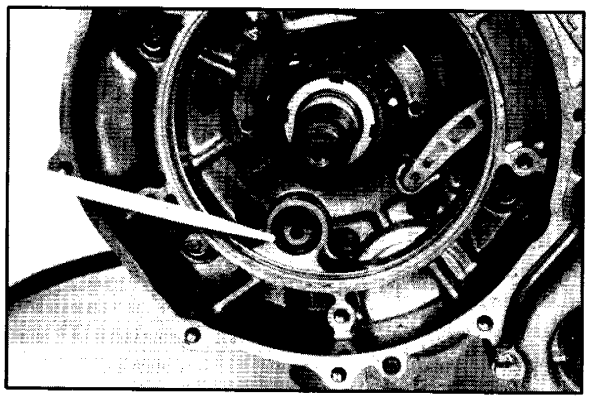
1. Install flywheel puller and remove flywheel. **CAUTION:** Do not thread the puller bolts into the flywheel more than 1/4" (.63 cm) or stator coils may be damaged.



2. Mark or note position of stator plate on crankcase.
3. Remove bolts and carefully remove stator assembly, being careful not to damage the crankshaft bushing or oil seal on the stator plate.
4. Wrap stator in a shop towel and secure stator out of the way on top of frame.



5. Remove oil passage O-Ring.
6. Place a shop towel in the cam chain area and over crankshaft oil passage.
7. Remove transmission linkage rods from shift selector and secure out of the way.
8. Remove PVT air intake duct.
9. Disconnect coolant temp sender wire.

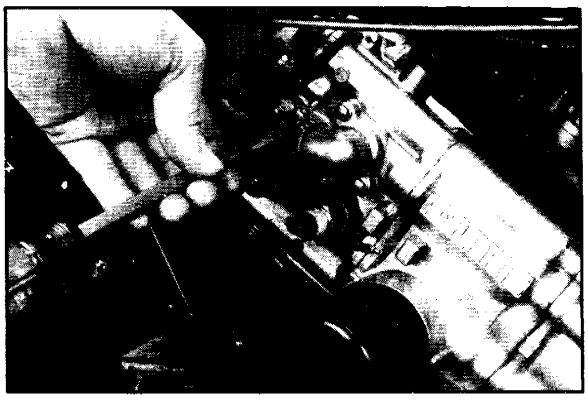


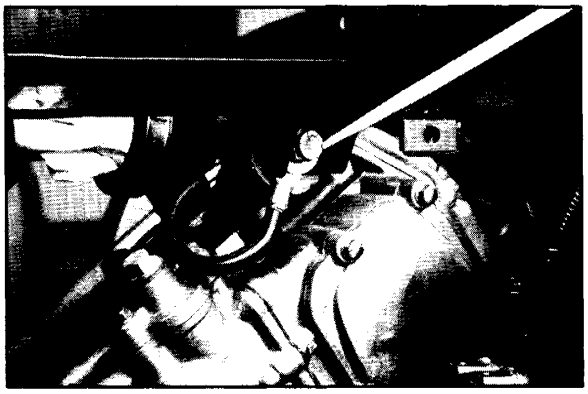
Removal, Cont.

5. Remove the following.
   - Starter motor. Note ground cable location. Mark positive (+) cable mounting angle and remove cable.
   - Oil tank bolts and oil tank, securing it out of the way.
   - Oil filter. Cover oil filter area with a shop towel.
6. Loosen oil line hose clamps and remove oil lines. **NOTE:** The uppermost line is the oil feed from the bottom of the tank. Cover both oil lines to prevent dirt from entering the line.
7. Remove coolant tank Torx™ screws and remove tank. Secure out of the way.
8. Loosen clamp and remove coolant line from thermostat housing. Drain the line into a suitable container. Plug end of thermostat housing to minimize spillage.

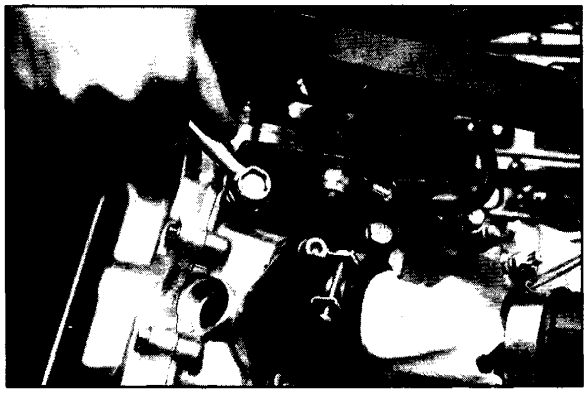
NOTE: Mark the center of the engine mount studs in the frame for reference upon installation.

9. Remove nut, ground cable and washer from the upper right engine mount and mark the location of the center of the mount stud.

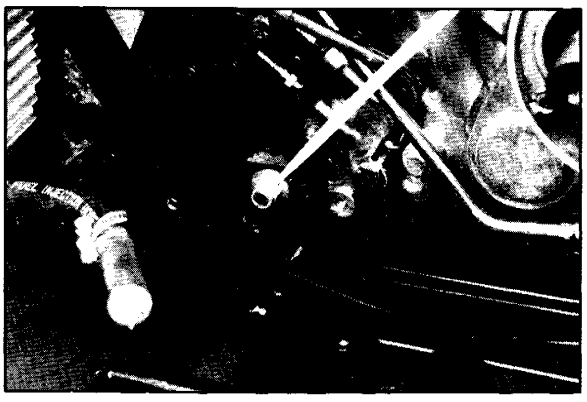




10. Remove the two upper engine mount plate bolts and remove the plate and ground cable.

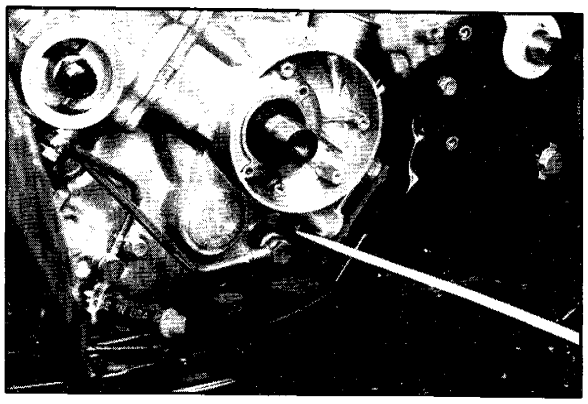


11. Remove nut and washer from lower left engine mount and mark location of stud. Some engines have the front motor mount located in front of the engine.



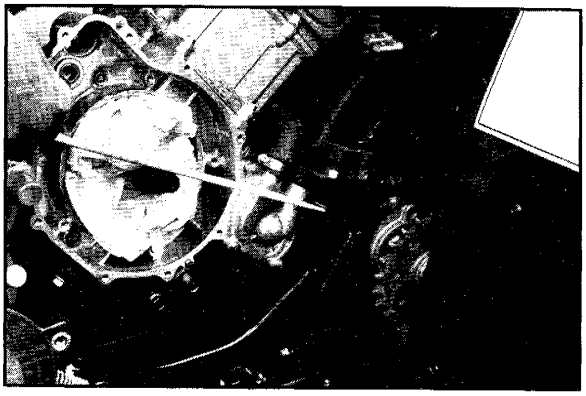
Removal, Cont.

17. Loosen nut on slotted rear engine mount plate and back it out to the end of the stud.

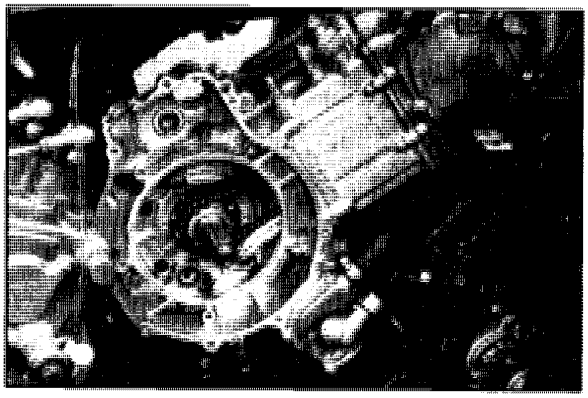


Final Coolant Draining/Engine Removal

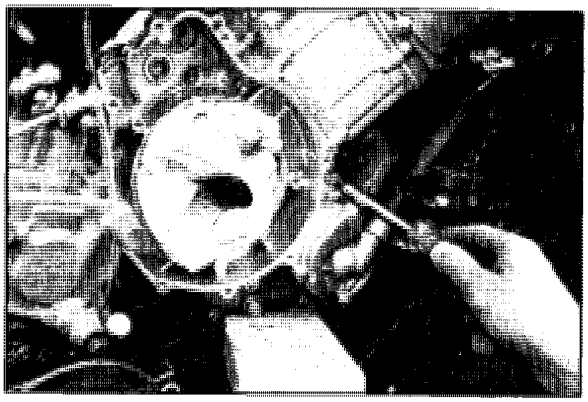
1. Move top of engine to left until the coolant supply hose clamp clears the frame at the water pump fitting.



2. Lift and twist engine clockwise until the lower left engine mount stud is clear of the frame mount and the lower right coolant hose clamp clears the frame tube.



3. Support engine in this position with a suitable support, such as a board or a 2x4.
4. Place a drain pan beneath area to catch coolant.
5. Clamp coolant inlet hose leading from radiator to pump to reduce coolant spillage.
6. Loosen hose clamp on upper water pump outlet coolant hose and remove hose, draining engine coolant into container. **NOTE:** Remove plug in thermostat housing to increase flow.
7. Reinstall hose and clamp.
8. Remove hose from water pump inlet and place in container. Release clamp from hose and allow hose to drain completely.
9. Lift back of engine while rotating front of engine clockwise and remove engine from left side of frame.

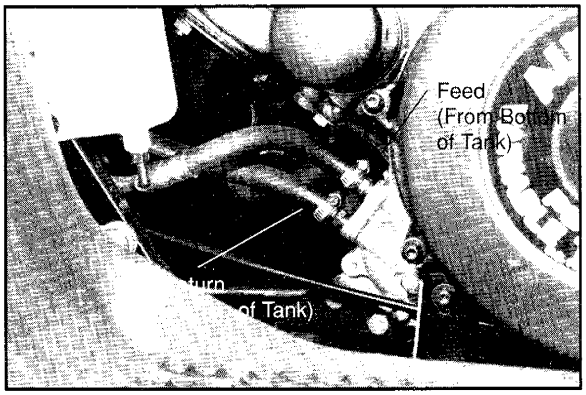


Engine Installation

1. Install engine from left side of frame, placing slotted rear engine plate in position with washer and nut on top of plate.
2. Attach water pump inlet hose and tighten clamp.
3. With engine in place on rear mount and inlet hose connected, tip top of engine to the left and rotate counterclockwise to engage lower left engine mount in frame.
4. Continue rotating engine making sure the hose clamp for the water pump inlet hose clears the frame at lower right side of engine near water pump.
5. Install upper engine mount bracket to engine and line up all reference marks.
6. Align engine by temporarily installing clutches and following alignment/offset procedure outlined in the PVT Chapter.
7. When engine is aligned properly, tighten all engine mounts and install all parts, reversing the order of disassembly. See engine installation notes.

Oil Supply

1. Before installing oil supply line, add Polaris Premium 4 0W/40 oil to the oil tank until oil flows from feed line.
2. Connect the lines to the pump inlet and outlet fitting and tighten securely. Be sure oil feed line is properly connected to the uppermost oil line fitting on the crankcase. Add oil until it is at the upper mark on dipstick.



Bleed Cooling System

1. Fill coolant reservoir tank to full mark.
2. With hose removed from thermostat housing, add coolant to radiator *slowly* until coolant begins to flow from thermostat housing.
3. Install hose on thermostat housing and tighten clamp. Continue to add coolant *slowly* until radiator is full.
4. Install radiator cap and squeeze coolant lines to force air out of system.
5. Remove cap and add coolant if necessary.
6. After reassembly is complete, start engine and observe coolant level in the radiator. Allow air to purge and top off as necessary. Reinstall radiator cap and bring engine to operating temp. Check level in reservoir tank after engine is cool and add coolant if necessary.

Transmission

1. Readjust transmission shift linkage as outlined in Transmission Chapter.

Exhaust

1. Seal all connections with high temp silicone seal.
2. Check to be sure all springs are in good condition.

Engine Disassembly

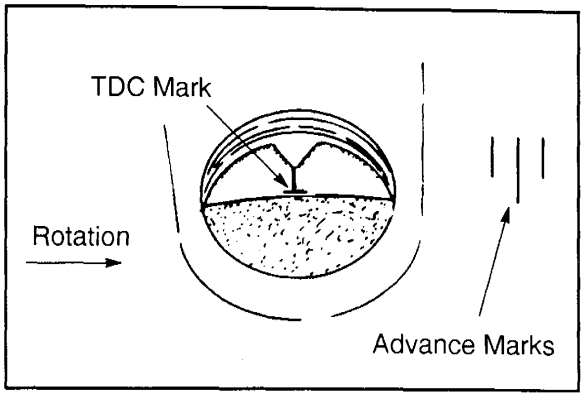
Cam Chain Tensioner/Rocker Arm/Camshaft Removal

1. Remove fuel tank and spark plug high tension lead. If camshaft is to be removed, drain engine coolant. See cooling system draining/refilling.
2. Remove bolt securing rocker cover and remove cover and gasket.
3. Remove ignition timing inspection plug from recoil housing.

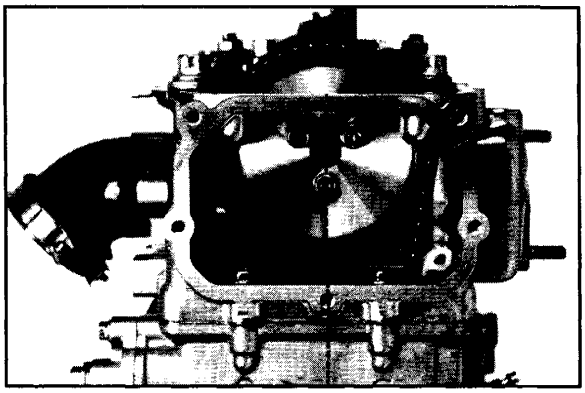
Engine Disassembly, Cont.

To position crankshaft at Top Dead Center (TDC) on compression stroke:

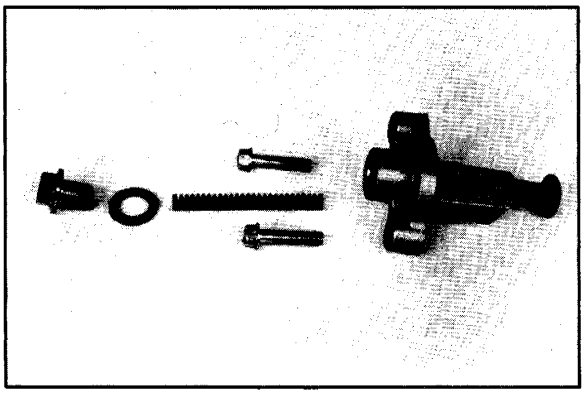
12. Rotate engine slowly in the direction of rotation watching intake valves open and start to close.
13. Continue to rotate engine slowly, watching camshaft sprocket marks and the mark in the timing inspection hole.



14. Align single (TDC) mark on flywheel with projection in inspection hole, and the cam sprocket pin (facing upward) aligned with the camshaft to crankshaft center line. **NOTE:** The cam lobes should be pointing down and all valves should have clearance at this point.

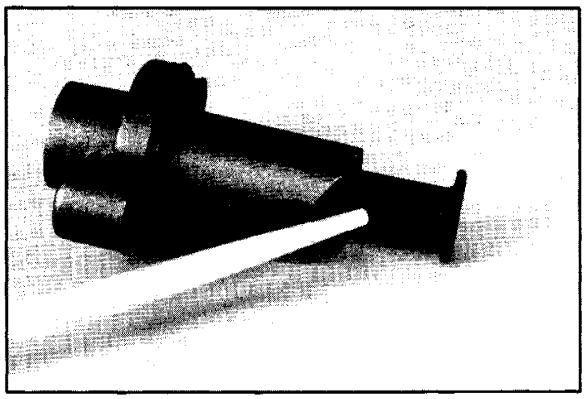


15. Remove cam chain tensioner plug, sealing washer, and spring. **CAUTION:** The plug is under spring tension. Maintain inward pressure while removing.
16. Remove the two 6x25 mm cam chain tensioner flange bolts.
17. Tap lightly on tensioner body with a soft face hammer and remove tensioner.



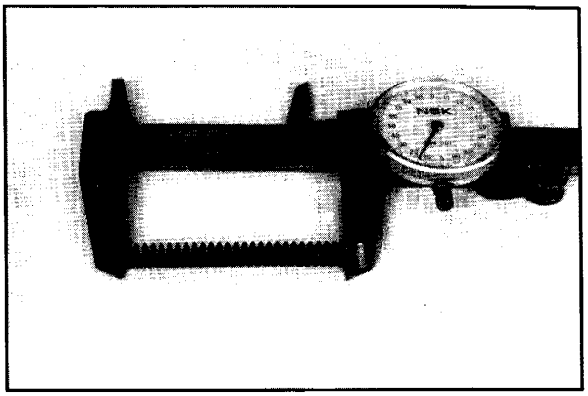
Cam Chain Tensioner Inspection

1. Pull cam chain tensioner plunger outward to the end of its travel. Inspect teeth on ratchet pawl and plunger for wear or damage.
2. Push ratchet pawl and hold it. The plunger should move smoothly in and out of the tensioner body.



Engine Disassembly, Cont.

3. Release ratchet pawl and push inward on plunger. It should remain locked in position and not move inward.
4. Measure free length of tensioner spring. Replace spring if excessively worn.

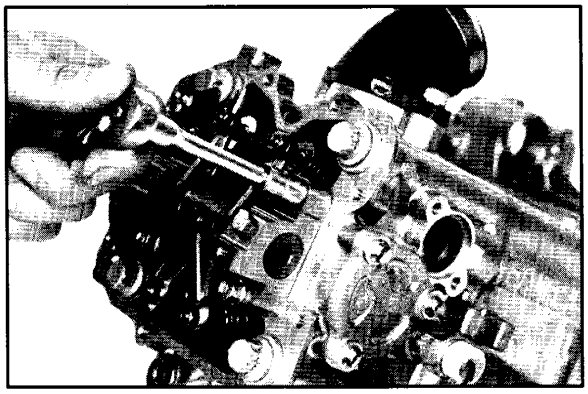


Tensioner Spring Free Length:
Std. 2.320" (5.9 cm)

5. Replace entire tensioner assembly if any part is worn or damaged.

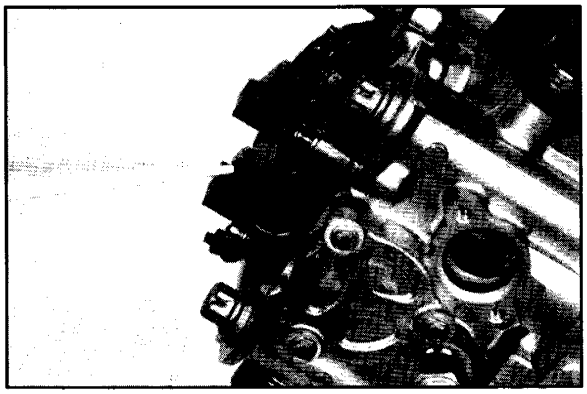
Rocker Arm/Shaft Removal

1. Loosen rocker shaft retaining bolt.
2. Remove the four bolts securing rocker shaft supports, and remove the supports, rocker shaft and rocker arms as an assembly, being careful not to drop the dowel pins into the engine.



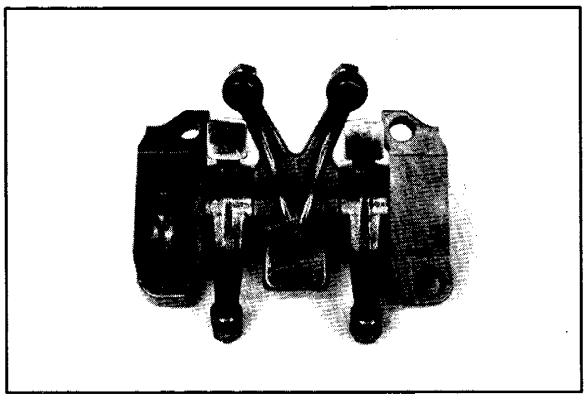
Rocker Arm/Shaft Inspection

1. Remove retaining bolt from the PTO (left) end rocker shaft support.
2. Mark or tag intake rocker arms so they can be installed in the same position.



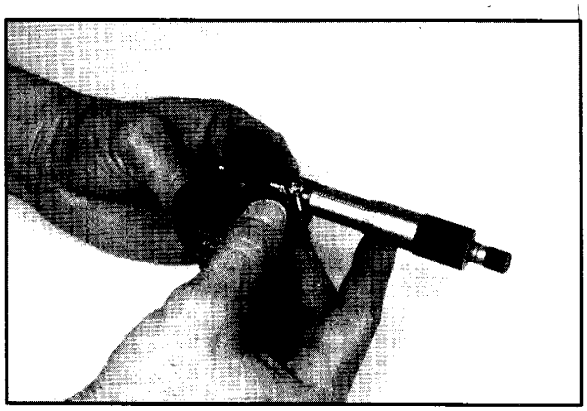
Rocker Shaft Retaining Bolt

3. Inspect each rocker arm cam follower surface. If there is any damage or uneven wear, replace the rocker arm. **NOTE:** Always inspect camshaft lobe if rocker arms are worn or damaged.

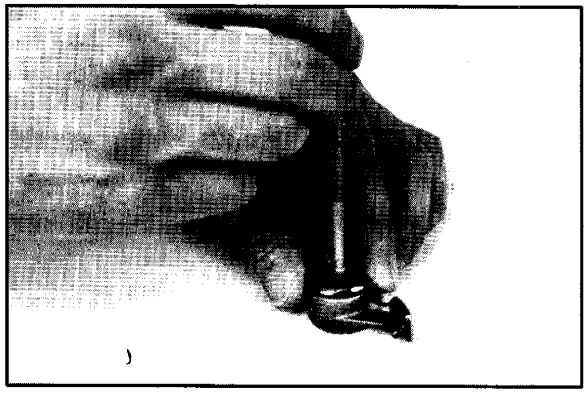


Engine Disassembly, Cont.

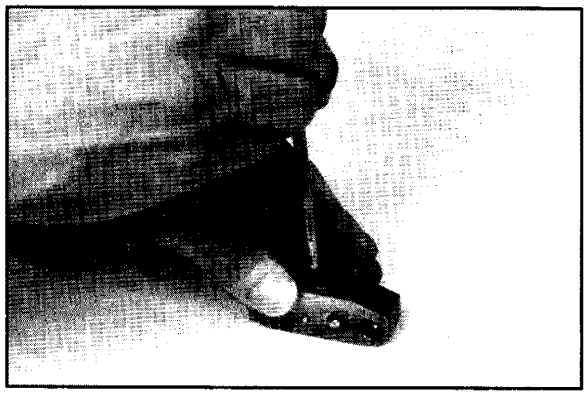
4. Measure O.D. of rocker shaft. Inspect it for wear or damage.



5. Measure I.D. of each rocker arm.



6. Measure I.D. of both rocker arm shaft supports and visually inspect surface.



Rocker Shaft OD:
.8656-.8661 (21.987-22.00 mm)

Rocker Arm ID and Shaft Support:
.8669-.8678 (22.020-22.041 mm)

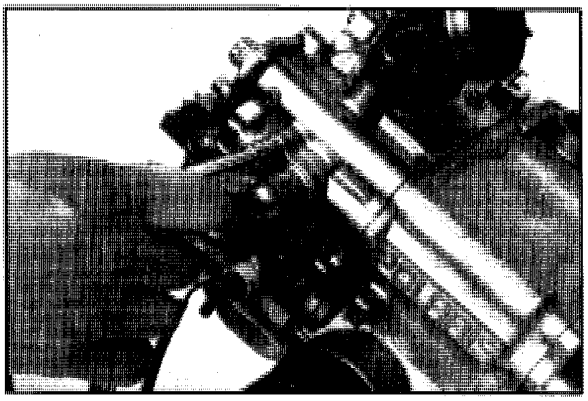
Clearance-Rocker Arm to Rocker Shaft:
Std: .0008-.0021 (.020-.054 mm)
Service Limit: .0039 (.10 mm)

7. Inspect rocker adjuster screws for wear, pitting, or damage to threads of the adjuster or locknut. Replace all worn or damaged parts. **NOTE:** The end of the adjuster screw is hardened and cannot be ground or re-faced.

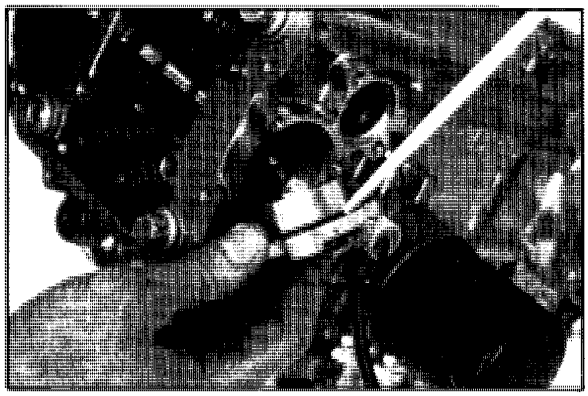
Engine Disassembly, Cont.

Camshaft Removal

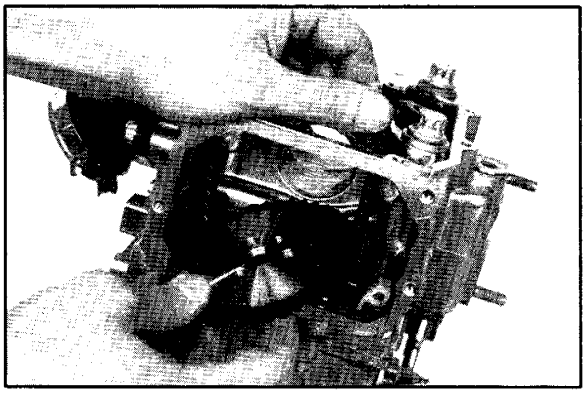
1. Remove camshaft sprocket inspection cover.
2. Loosen three camshaft sprocket bolts.
3. Remove thermostat housing and thermostat. Note the location of the air bleed holes in the thermostat. Upon reassembly, the thermostat bleed holes should be positioned next to the holes for the thermostat cover bolts.



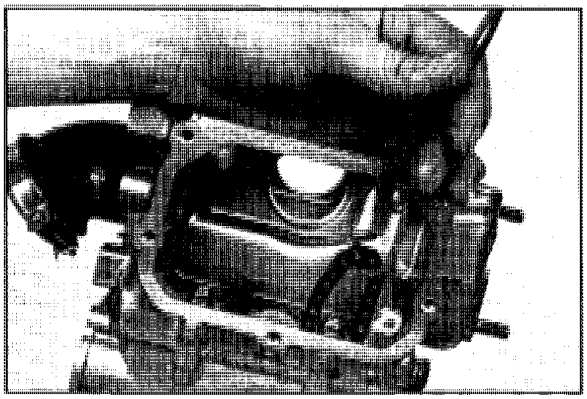
4. Remove camshaft end cap and O-Ring.
5. Place a clean shop towel in the area below cam chain sprocket and remove sprocket retaining bolts.



6. Slide camshaft inward to allow removal of cam sprocket and remove sprocket from camshaft and chain.



7. Secure cam chain with a wire to prevent it from falling into the crankcase.
8. Inspect cam sprocket teeth for wear or damage. Replace if necessary.
9. Slide camshaft out the PTO side of the cylinder head.

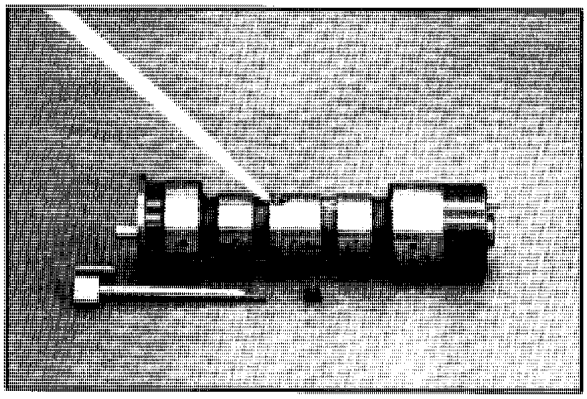


Engine Disassembly, Cont.

Automatic Compression Release Removal/Inspection

NOTE: The automatic compression release mechanism can be inspected and serviced without removing the camshaft from the cylinder head. The actuator ball in the camshaft is not replaceable. Replace the camshaft as an assembly if the actuator ball is worn or damaged.

1. Check release lever shaft for smooth operation throughout the entire range of rotation. The spring should hold the shaft weight against the stop pin. In this position, the actuator ball will be held outward in the compression release mode.
2. Remove release lever shaft and return spring.
3. Inspect shaft for wear or galling.
4. Inspect lobe on end of release lever shaft and actuator ball for wear and replace if necessary.



Automatic Compression Release Installation

1. Slide spring onto shaft.
2. Apply engine oil to release lever shaft.

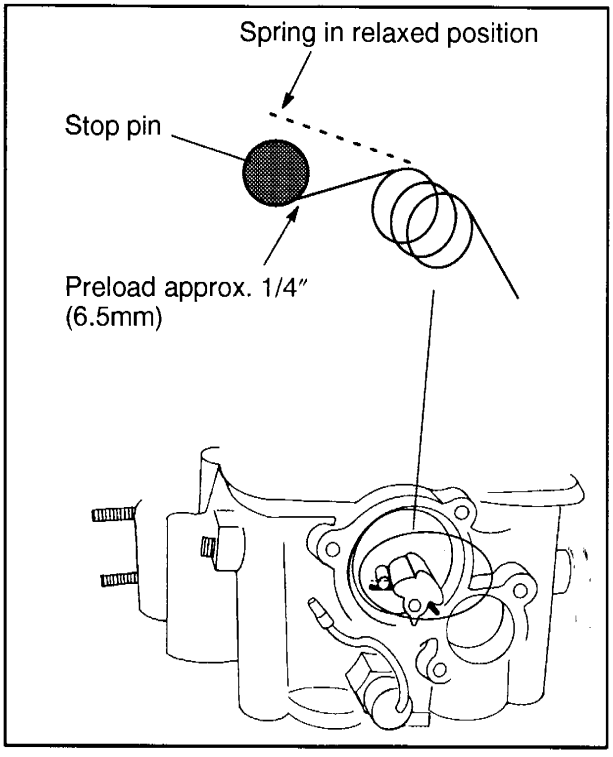
The actuator ball must be held outward to allow installation of the release lever shaft.

If Camshaft Is Removed From Engine:

3. Turn the camshaft until the actuator ball is in the lowest position and install the release lever shaft, pre-winding the spring approximately 1/4" (6.5mm).

If Camshaft Is Installed In The Engine:

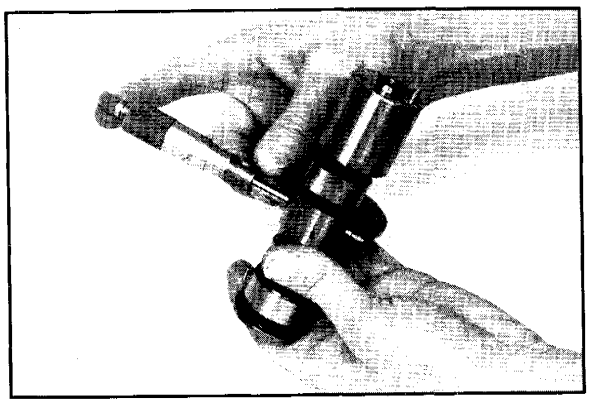
4. Use a small magnet to draw the actuator ball outward, or rotate the engine until the cam lobes face upward and install release lever shaft.
5. Position camshaft as shown at bottom of illustration at right.
6. Place arm of spring under stop pin as shown and push release lever inward until fully seated. *Do not* pre-wind the spring one full turn or the compression release will not disengage when the engine starts. Check operation of mechanism as outlined in step 1 of Removal (above).
   NOTE: When shaft is properly installed, actuator ball will be held in the "out" position. It is important to note that spring pressure is very light.



Engine Disassembly, Cont.

Camshaft Inspection

1. Visually inspect each cam lobe for wear, chafing or damage.
2. Thoroughly clean the cam shaft, making sure the oil feed holes are not obstructed.
3. Measure height of each cam lobe using a micrometer.

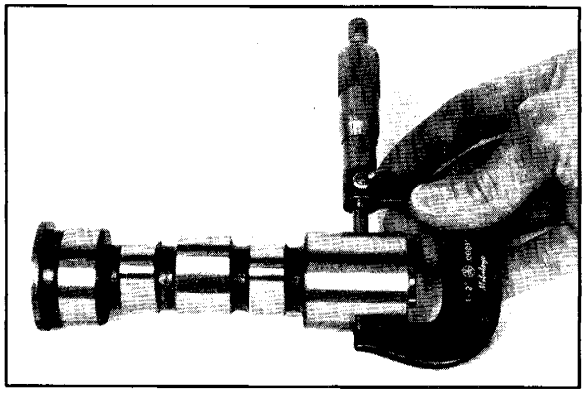


Intake Cam Lobe Height:

Std: 1.2884-1.2924 (32.726-32.826 mm)
Limit: 1.2766 (32.426 mm)

Exhaust Cam Lobe Height:
Std: 1.2884-1.2924 (32.726-32.826 mm)
Limit: 1.2766 (32.426 mm)

4. Measure camshaft journal OD.
5. Measure ID of camshaft journal bore.
6. Calculate oil clearance by subtracting journal OD from journal bore ID.



Camshaft Journal OD
Mag: 1.4935-1.4941 (37.935-37.950 mm)
PTO: 1.4935-1.4941 (37.935-37.950 mm)

Camshaft Journal Bore ID
Mag: 1.4963-1.4970 (38.005-38.025 mm)
PTO: 1.4963-1.4970 (38.005-38.025 mm)

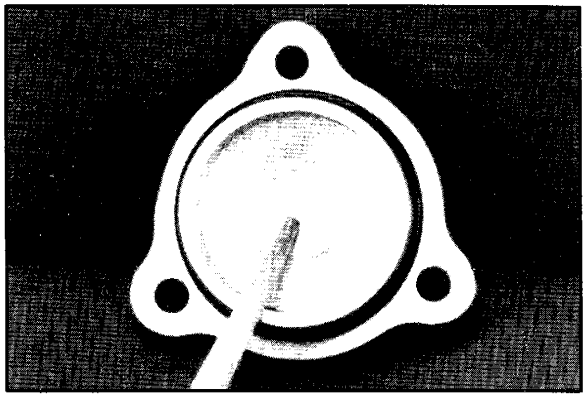
Oil Clearance
Std: .0022-.0035 (.055-.090 mm)
Limit: .0039 (.10 mm)

Engine Disassembly, Cont.

Replace camshaft if damaged or if any part is worn past the service limit.

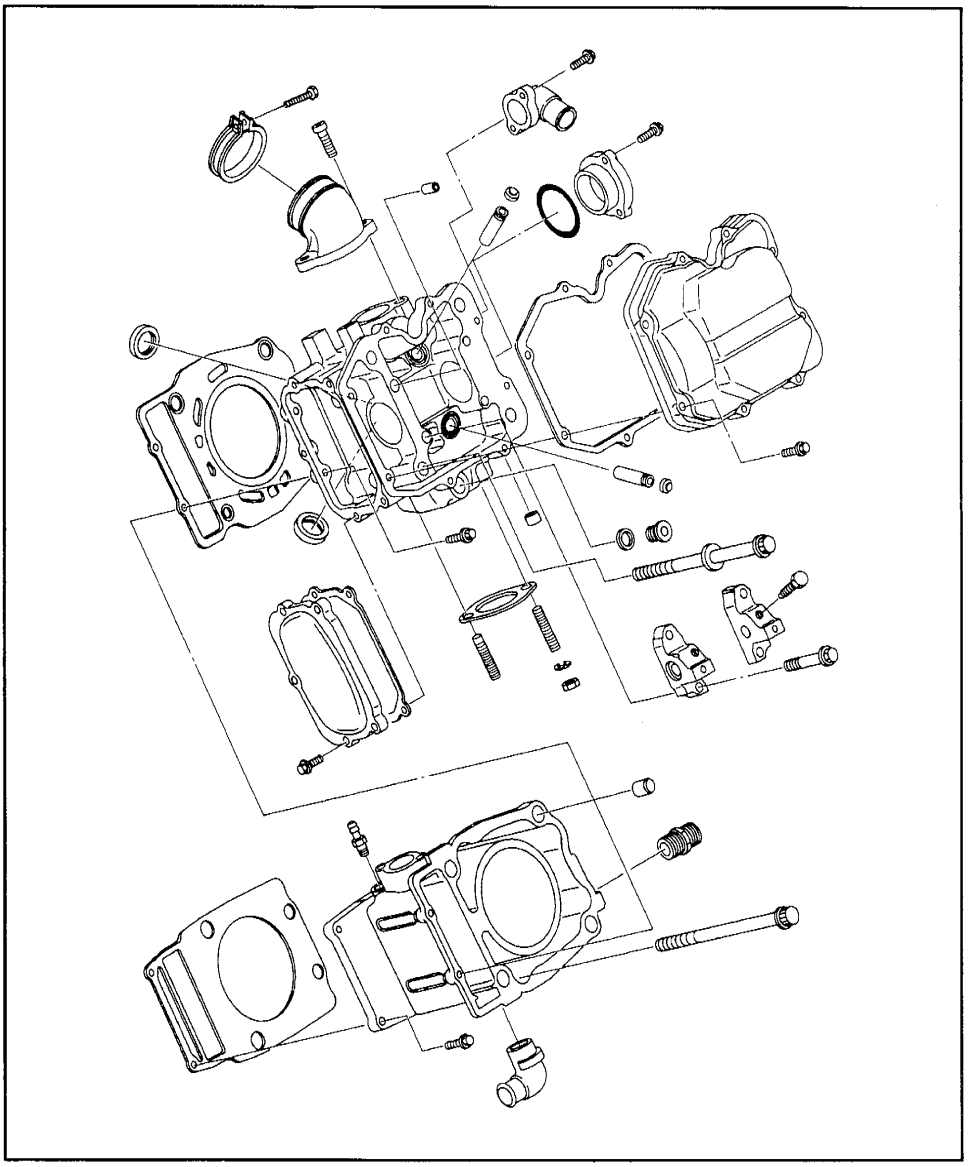
Replace cylinder head if camshaft journal bore is damaged or worn excessively.

7. Inspect camshaft end cap (thrust face) for wear. Replace if worn or damaged.



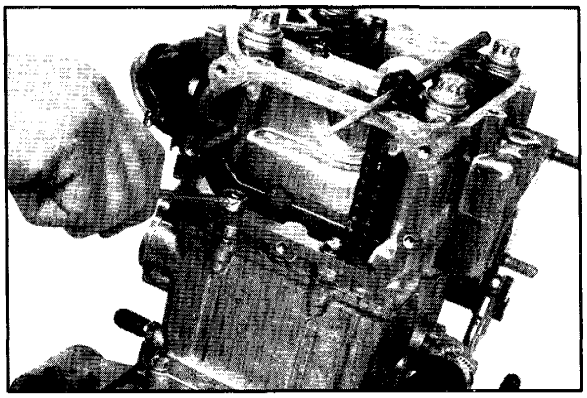
Cylinder Head Removal

See appropriate chapter to remove the following: fuel tank, spark plug high tension lead, exhaust pipe, carburetor, and top engine mount plate. Drain coolant. Remove cam chain tensioner, camshaft, and rocker assembly.

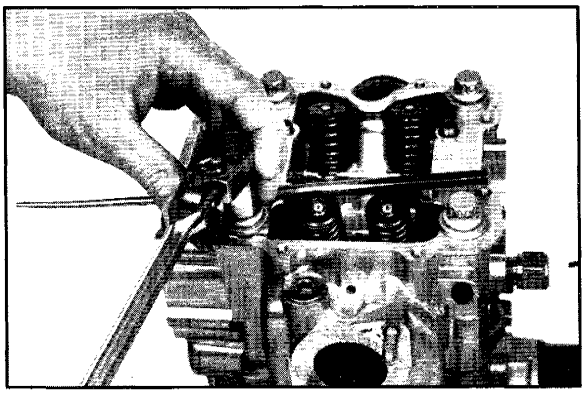


Engine Disassembly, Cont.

1. Remove the two 6x28 mm flange bolts from cylinder head.

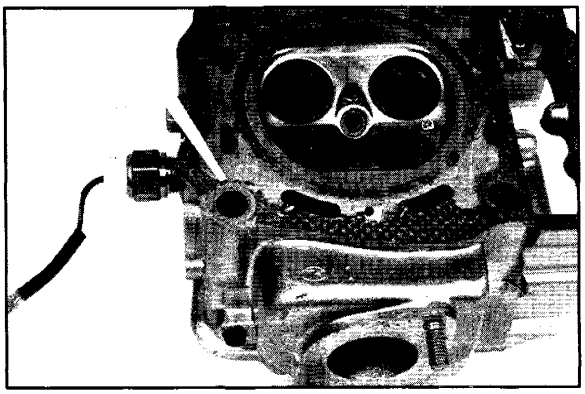


2. Loosen each of the four 11x191 mm cylinder head bolts evenly 1/8 turn each time in a criss-cross pattern until loose.
3. Remove bolts and tap cylinder head lightly with a plastic hammer until loose. **CAUTION:** Tap only in reinforced areas or on thick parts of cylinder head casting to avoid damaging casting.



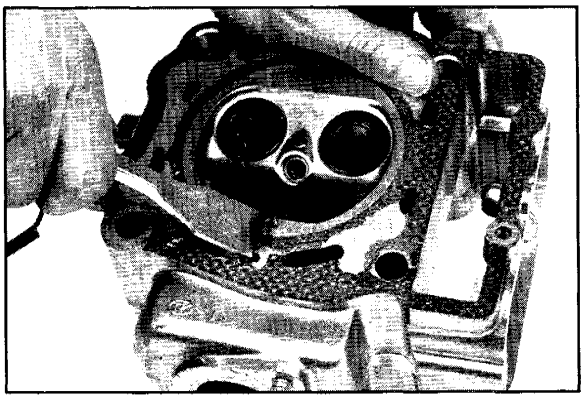
4. Remove cylinder head and head gasket. Note the O-Ring in the corner of the gasket which seals the front left cylinder stud. The O-Ring is part of the fiber type gasket.

NOTE: This gasket has been superceded by an all metal gasket which does not require an O-ring.



Cylinder Head Disassembly/Inspection

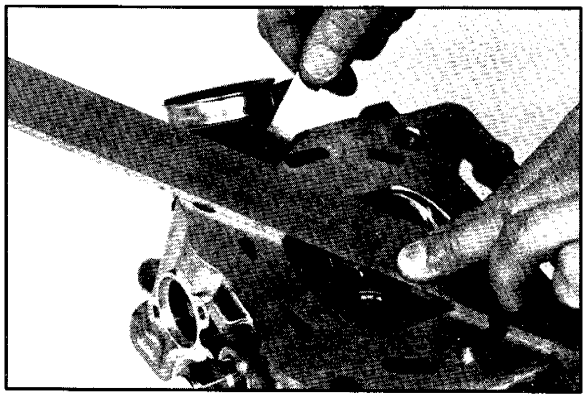
1. Thoroughly clean cylinder head surface to remove all traces of gasket material and carbon. **CAUTION:** Use care not to damage sealing surface.



Engine Disassembly, Cont.

Cylinder Head Warpage

1. Lay a straight edge across the surface of the cylinder head at several different points and measure warpage by inserting a feeler gauge between the straight edge and the cylinder head surface. If warpage exceeds the service limit, replace the cylinder head.



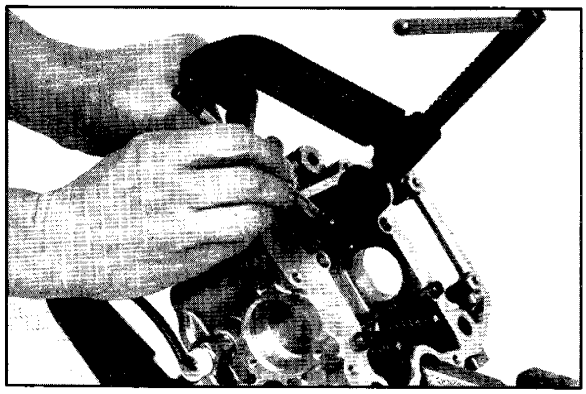
Cylinder Head Warpage Limit:
.002" (.05 mm)

Cylinder Head Disassembly

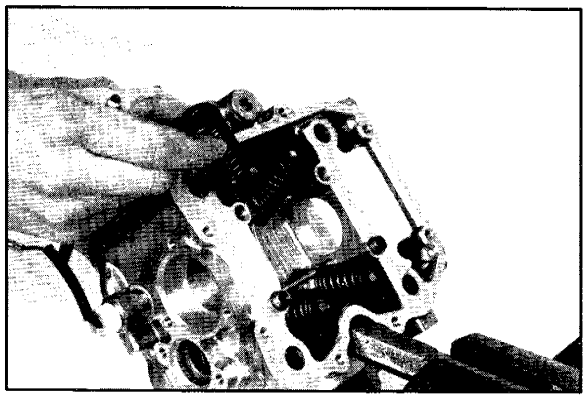
WARNING: Wear eye protection or a face shield during cylinder head disassembly and reassembly.

NOTE: Keep all parts in order with respect to their location in the cylinder head.

1. Using a valve spring compressor, compress the valve spring and remove the split keeper. **NOTE:** To prevent loss of tension, do not compress the valve spring more than necessary.



2. Remove spring retainer and spring. **NOTE:** The valve springs should be positioned with the tightly wound coils against the cylinder head.
3. Push valve out, keeping it in order for reassembly in the same guide.



Engine Disassembly, Cont.

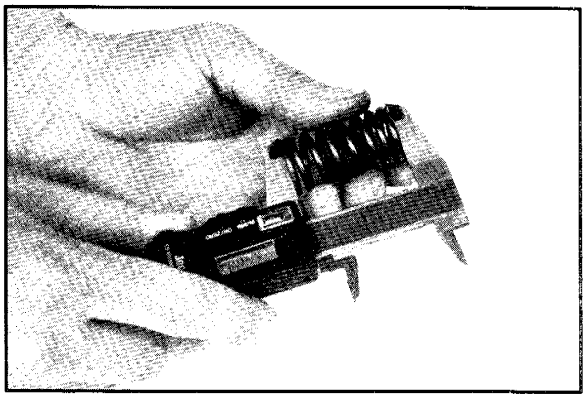
4. Measure free length of spring with a Vernier caliper. Check spring for squareness. Replace spring if either measurement is out of specification.

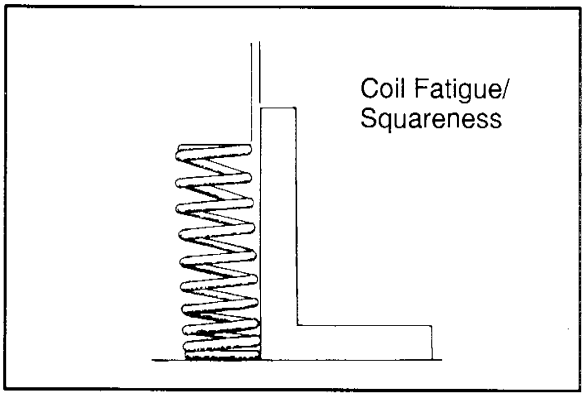
Valve Spring Free Length

Orange Std: 1.7342 (44.05 mm)
Orange Limit: 1.656 (42.05 mm)

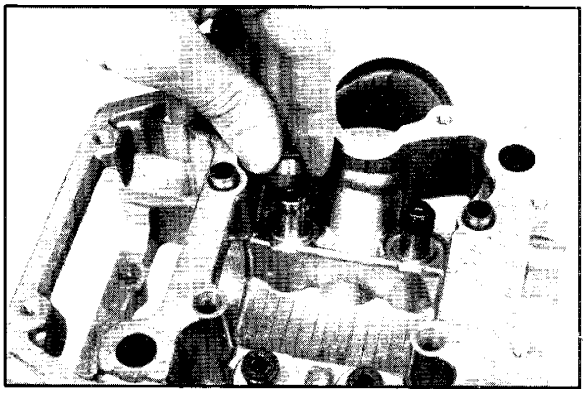
Yellow Std: 1.654 (42.0 mm)
Yellow Limit: 1.575 (40.0 mm)

Squareness: 2.5° (.075") (1.9 mm)





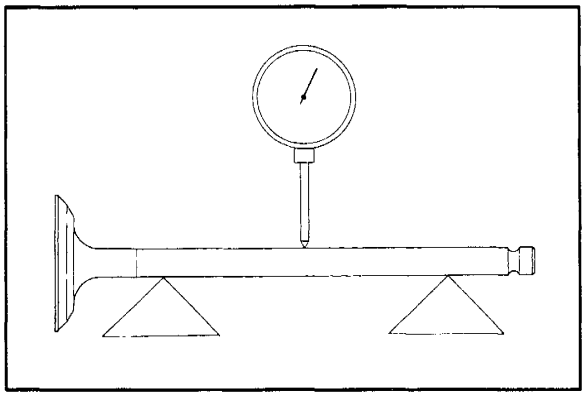
5. Remove valve seals. **CAUTION:** Replace seals whenever the cylinder head is disassembled. Hardened, cracked or worn valve seals will cause excessive oil consumption and carbon buildup.



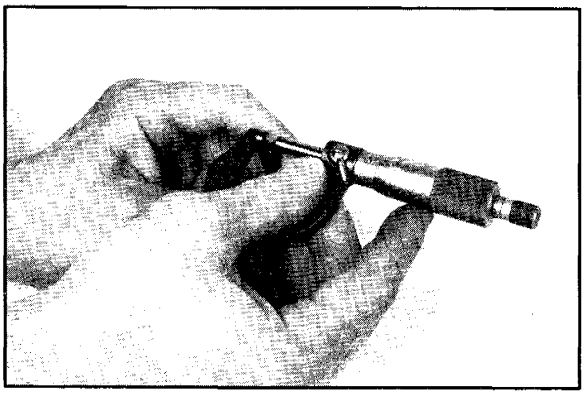
Engine Disassembly, Cont.

Valve Inspection

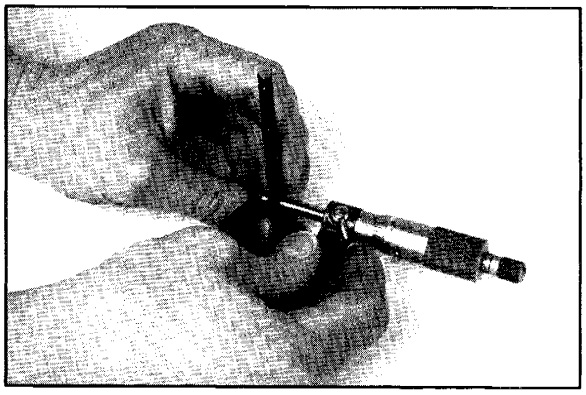
1. Remove all carbon from valve with a soft wire wheel.
2. Check valve face for runout, pitting, and burnt spots. To check for bent valve stems, mount valve in a drill or use "V" blocks and a dial indicator.



3. Check end of valve stem for flaring, pitting, wear or damage.
4. Inspect split keeper groove for wear or flaring of the keeper seat area. **NOTE:** The Stellite™ valves cannot be re-faced or end ground. They must be replaced if worn, bent, or damaged.



5. Measure diameter of valve stem with a micrometer in three places and in two different directions (six measurements total).

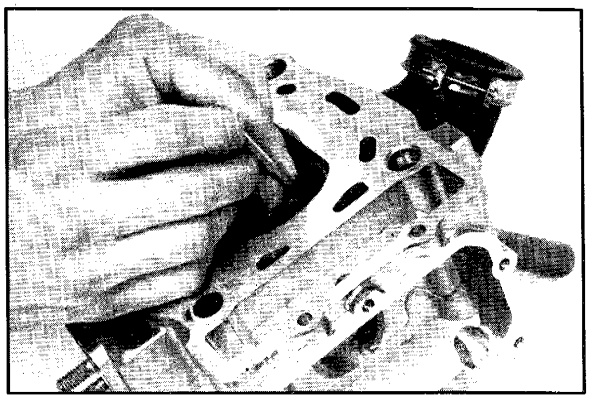


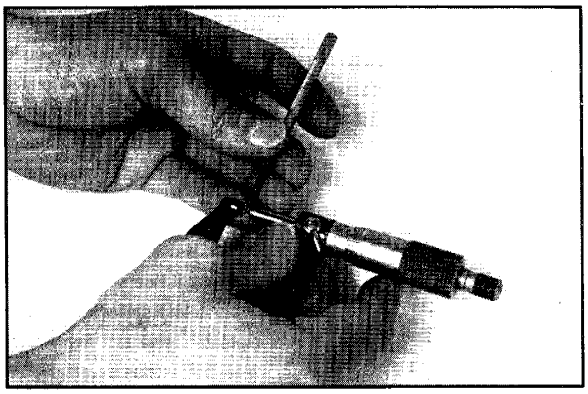
Valve Stem Diameter
Intake: .2343-.2348 (5.950-5.965 mm)
Exhaust: .2341-.2346 (5.945-5.960 mm)

Engine Disassembly, Cont.

6. Measure valve guide inside diameter at the top middle and end of the guide using a small hole gauge and a micrometer. Measure in two directions, front to back and side to side.
7. Subtract valve stem measurement to obtain stem to guide clearance. **NOTE:** Be sure to measure each guide and valve combination individually.
8. Replace valve and/or guide if clearance is excessive.

NOTE: If valve guides are replaced, valve seats must be reconditioned.





Valve Guide Inside Diameter:
.2362-.2367 (6.000-6.012 mm)

Stem to Guide Clearance:
Std. Intake: .0014-.0024 (.035-.062 mm)

Std. Exhaust: .0016-.0026 (.040-.067 mm

Limit: .0059 (.15 mm)

Combustion Chamber

Clean all accumulated carbon deposits from combustion chamber and valve seat area with a soft wire brush.

Valve Seat Inspection

Inspect valve seat in cylinder head for pitting, burnt spots, roughness, and uneven surface. If any of the above conditions exist, the valve seat must be reconditioned. See Valve Seat Reconditioning, page 3.56. *If the valve seat is cracked the cylinder head must be replaced.*

Cylinder Head Reconditioning

NOTE: Servicing the valve guides and valve seats requires special tools and a thorough knowledge of reconditioning techniques. Follow the instructions provided in the cylinder head service tool kit.

CAUTION: Wear eye protection when performing cylinder head service. Valve guide replacement will require heating of the cylinder head. Wear gloves to prevent burns.

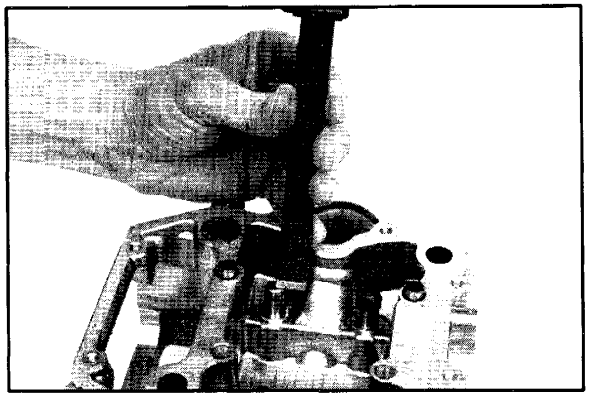
Valve Guide Removal/Installation

1. Remove all carbon deposits from the combustion chamber, valve seat and valve guide area before attempting to remove valve guides. **CAUTION:** Carbon deposits are extremely abrasive and may damage the valve guide bore when guides are removed.
2. Place new valve guides in a freezer for at least 15 minutes while heating cylinder head.
3. Heat cylinder head in an oven or use a hot plate to bring cylinder head temperature to 212° F (100° C). **CAUTION:** Do not use a torch to heat cylinder head or warpage may result from uneven heating. Head temperature can be checked with a pyrometer or a welding temperature stick.
4. When thoroughly heated, place cylinder head on blocks of wood which will allow the old guides to be removed.
5. Using valve guide driver, drive guides out of the cylinder head from the combustion chamber side. Be careful not to damage guide bore or valve seat when removing guides.

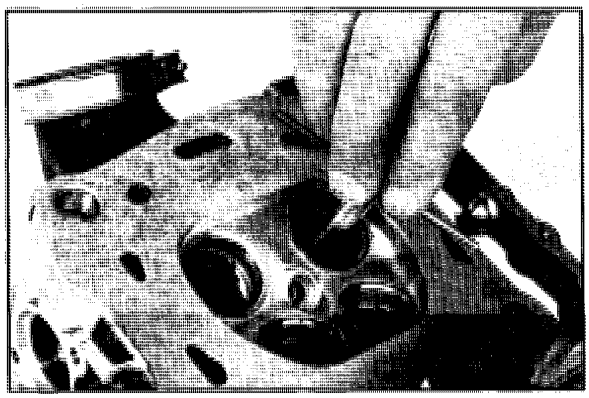
Engine Disassembly, Cont.

6. Place cylinder head on cylinder head table. **NOTE:** Be sure cylinder head is still at 212° F (100° C) before installing new guides.
7. Place a new guide in the valve guide installation tool and press guide in to proper depth. Check height of each guide above the cylinder head. **NOTE:** The guide can be driven in to the proper depth. Inspect the guide closely for cracks or damage if a driver is used.

Protrusion Above Head:
.689-.709 (17.5-18.0 mm)



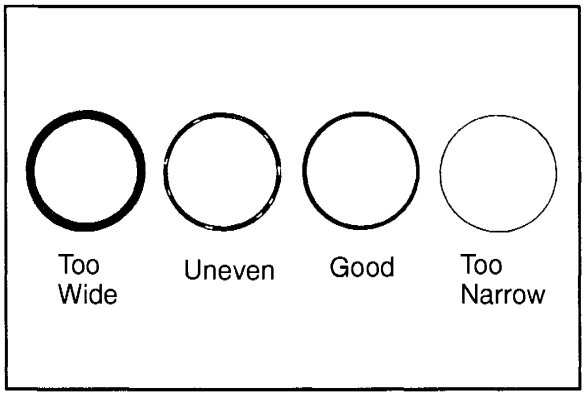
8. Allow cylinder head to cool to room temperature. Apply cutting oil to the reamer supplied with the cylinder head service kit. Guides should be reamed from the valve spring side of the cylinder head. Ream each guide to size by turning the reamer clockwise continually. Continue to rotate reamer clockwise during removal of the tool.
9. Clean guides thoroughly with hot soapy water and a nylon brush. Rinse and dry with compressed air. Apply clean engine oil to guides.



Valve Seat Reconditioning

Follow the manufacturers instructions provided with the valve seat cutters in the Cylinder Head Reconditioning Kit (PN 2200634). Abrasive stone seat reconditioning equipment can also be used. Keep all valves in order with their respective seat.

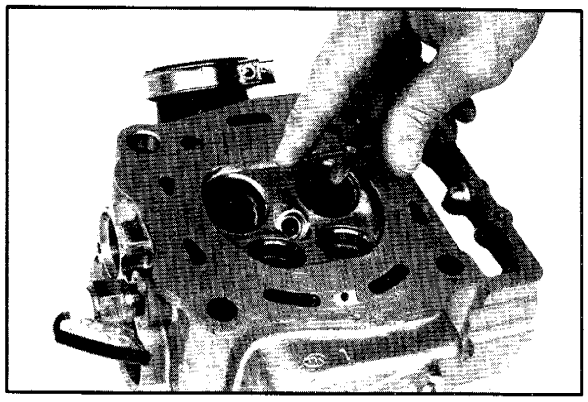
NOTE: Valve seat width and point of contact on the valve face is very important for proper sealing. The valve must contact the valve seat over the entire circumference of the seat, and the seat must be the proper width all the way around. If the seat is uneven, compression leakage will result. If the seat is too wide, seat pressure is reduced, causing carbon accumulation and possible compression loss. If the seat is too narrow, heat transfer from valve to seat is reduced and the valve may overheat and warp, resulting in burnt valves.



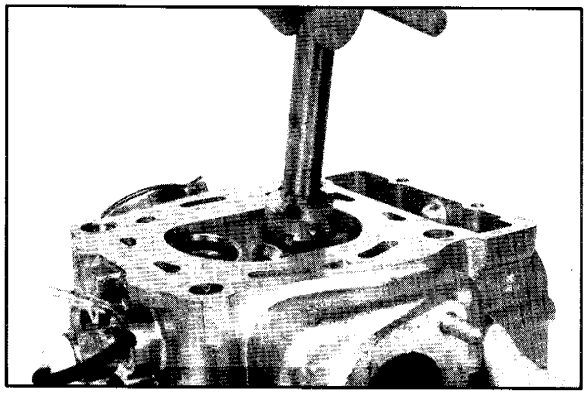
Engine Disassembly, Cont.

Valve Seat Reconditioning

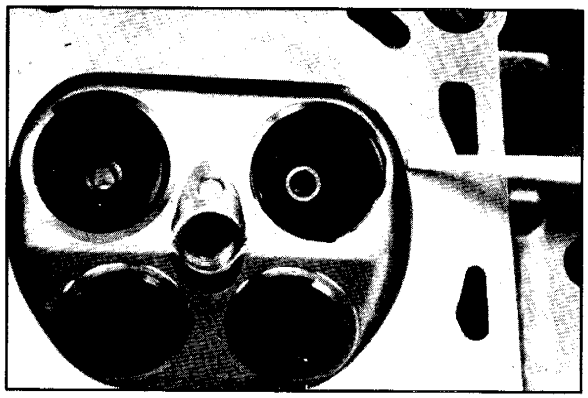
1. Install pilot into valve guide.
2. Apply cutting oil to valve seat and cutter.



3. Place 46° cutter on the pilot and make a light cut.
4. Inspect the cut area of the seat.
   - If the contact area is less than 75% of the circumference of the seat, rotate the pilot 180° and make another light cut.
   - If the cutter now contacts the uncut portion of the seat, check the pilot. Look for burrs, nicks, or runout. If the pilot is bent it must be replaced.
   - If the contact area of the cutter is in the same place, the valve guide is distorted from improper installation and must be replaced. Be sure the cylinder head is at the proper temperature and replace the guide.
   - If the contact area of the initial cut is greater than 75%, continue to cut the seat until all pits are removed and a new seat surface is evident. **NOTE:** Remove only the amount of material necessary to repair the seat surface.

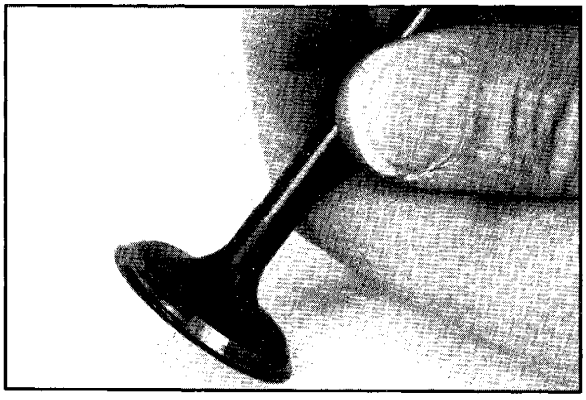


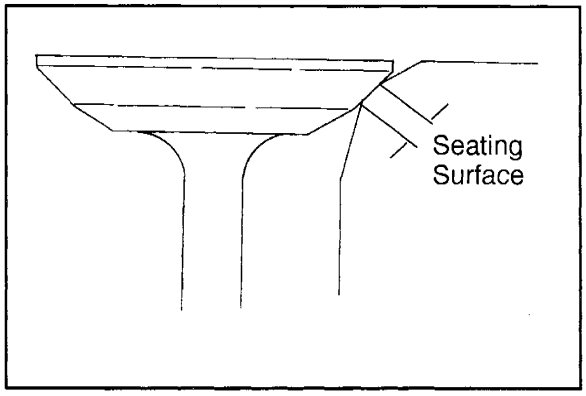
5. To check the contact area of the seat on the valve face, apply a thin coating of Prussian Blue™ paste to the valve seat.
6. Insert valve into guide and tap valve lightly into place a few times.

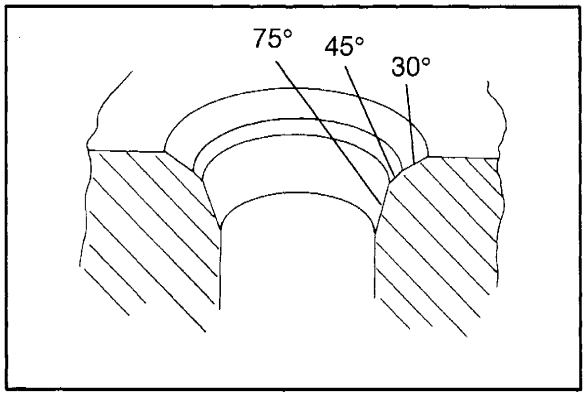


Engine Disassembly, Cont.

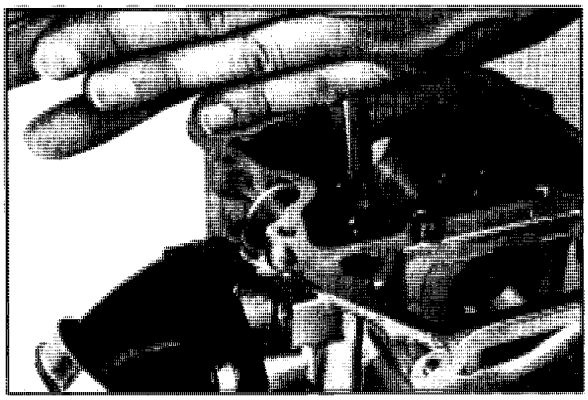
7. Remove valve and check where the Prussian Blue™ indicates seat contact on the valve face. The valve seat should contact the middle of the valve face and must be the proper width.
   - If the indicated seat contact is too high on the valve face, use the 30° or 31° cutter to lower the valve seat.
   - If too low use the 60° or 75° cutter to raise the seat. When contact area is centered on the valve face, measure seat width.
   - If the seat is too wide or uneven, use both top and bottom cutters to narrow the seat.
   - If the seat is too narrow, widen using the 46° cutter and re-check contact point on the valve face and seat width after each cut.
8. Clean all filings from the area with hot soapy water, rinse, and dry with compressed air.
9. Lubricate the valve guides with clean engine oil, and apply oil or water based lapping compound to the face of the valve.





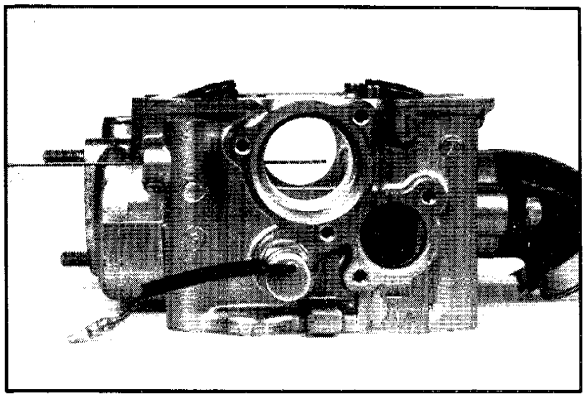


10. Insert the valve into its respective guide and lap using a lapping tool or a section of fuel line connected to the valve stem.
11. Rotate the valve rapidly back and forth until the cut sounds smooth. Lift the valve slightly off of the seat, rotate 1/4 turn, and repeat the lapping process. Do this four to five times until the valve is fully seated, and repeat process for the other three valves.
12. Remove oil passage blind plug and thoroughly clean cylinder head and valves.



Engine Disassembly, Cont.

13. After cylinder head and oil passage are clean, apply 3 Bond 1215 or equivalent sealer to the threads of the blind plug and install, torquing to 8 ft. lbs. (1.1 kg-m). **CAUTION:** Do not allow sealer to enter oil passage.
14. Spray electrical contact cleaner into oil passage and dry using compressed air.

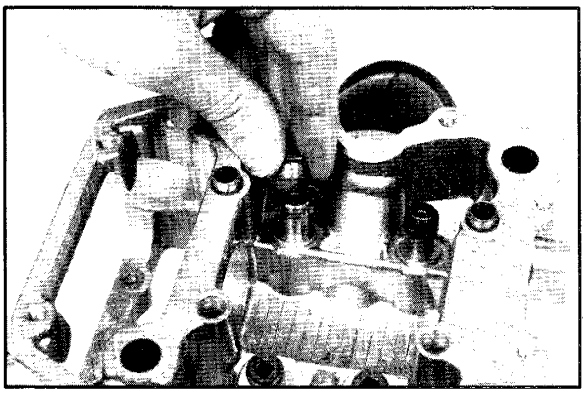


Cylinder Head Assembly

CAUTION: Wear eye protection during assembly.

NOTE: Assemble the valves one at a time to maintain proper order.

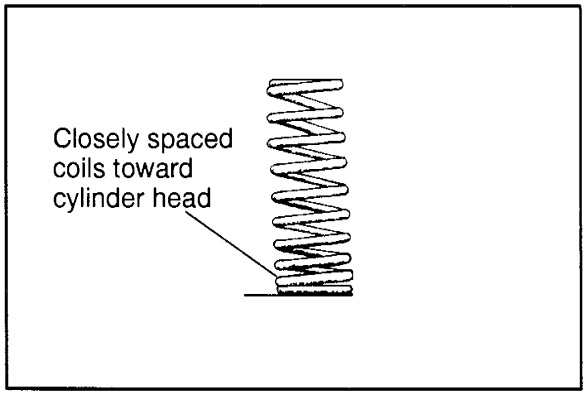
1. Install new valve seals on valve guides. **NOTE:** The intake and exhaust valve seals are different, and must be installed on the proper guide.



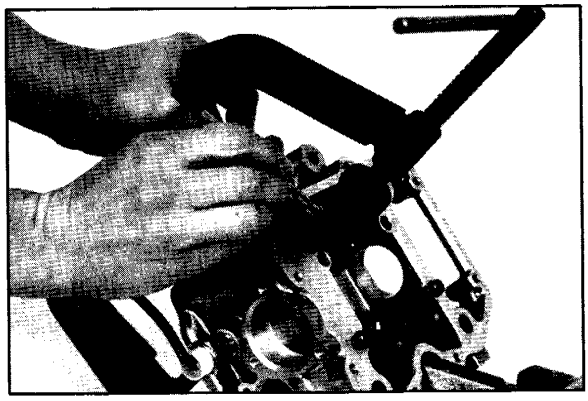
Intake Seal PN 3084857, Black

Exhaust Seal PN 3084859, Brown

2. Apply engine oil to valve guides and seats.
3. Coat valve stem with molybdenum disulfide grease.
4. Install valve carefully with a rotating motion to avoid damaging valve seal.
5. Dip valve spring and retainer in clean engine oil and install spring with closely spaced coils toward the cylinder head.



6. Place retainer on spring and install valve spring compressor. Compress spring only enough to allow split keeper installation to prevent loss of spring tension. Install split keepers with the gap even on both sides.
7. Repeat procedure for remaining valves.
8. When all valves are installed, tap lightly with soft faced hammer on the end of the valves to seat the split keepers.



Engine Disassembly, Cont.

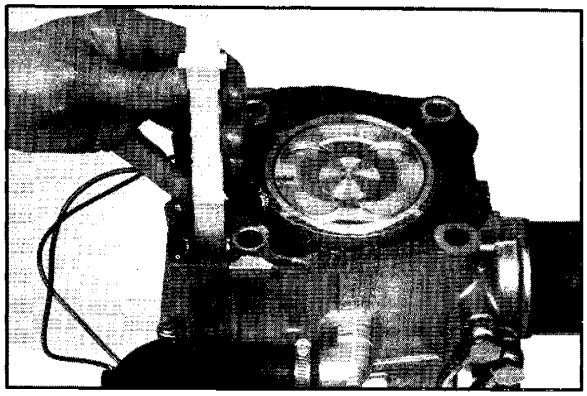
Valve Sealing Test

1. Clean and dry the combustion chamber area.
2. Pour a small amount of clean, high flash point solvent into the intake port and check for leakage around each intake valve. The valve seats should hold fluid with no seepage.
3. Repeat for exhaust valves by pouring fluid into exhaust port.

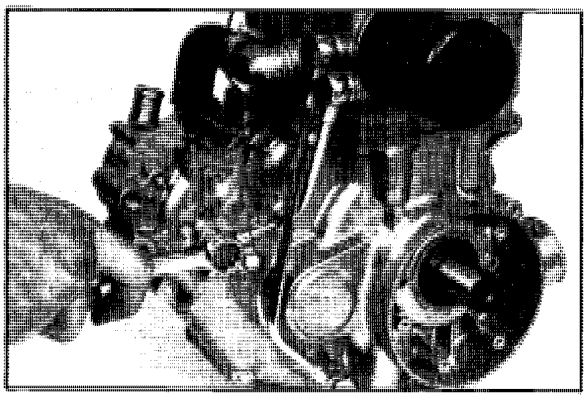
Cylinder/Piston Removal and Inspection

Follow engine disassembly procedures to remove valve cover, camshaft and rocker arms, and cylinder head.

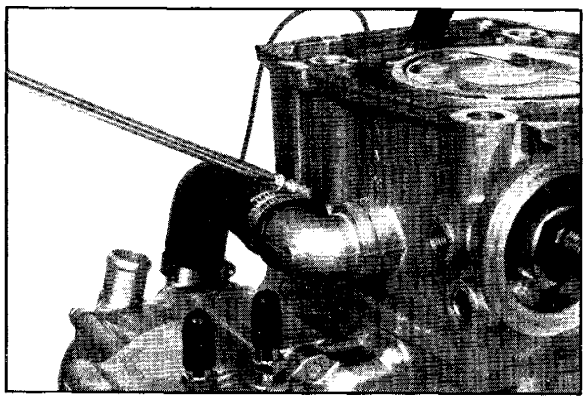
1. Remove cam chain guide at front of cylinder.



2. Loosen all four oil pipe banjo bolts and then remove the bolts and eight sealing washers. Remove the pipes.

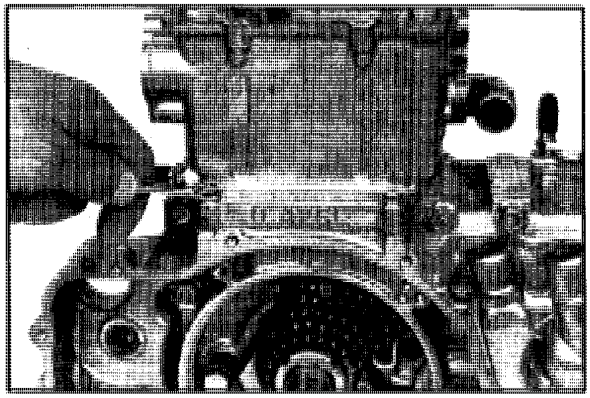


3. Loosen hose clamps on coolant inlet hose and remove hose.

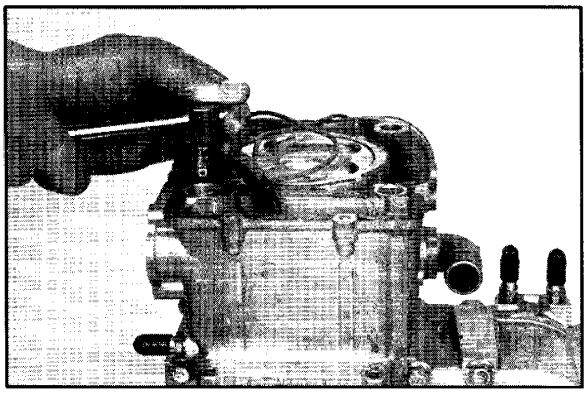


Engine Disassembly, Cont.

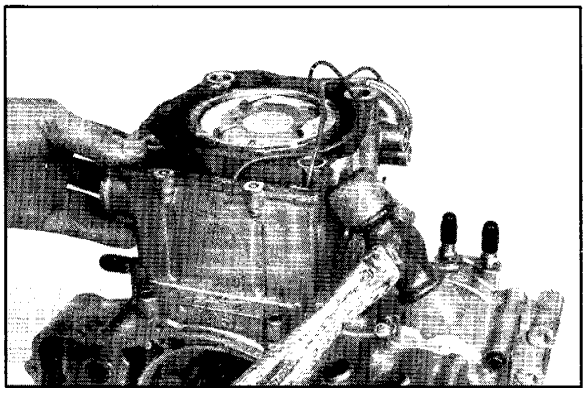
4. Remove the two 6 mm cylinder base bolts.



5. Loosen each of the four cylinder base bolts inside the water jacket 1/4 turn at a time in a criss-cross pattern until loose.
6. Remove the bolts.

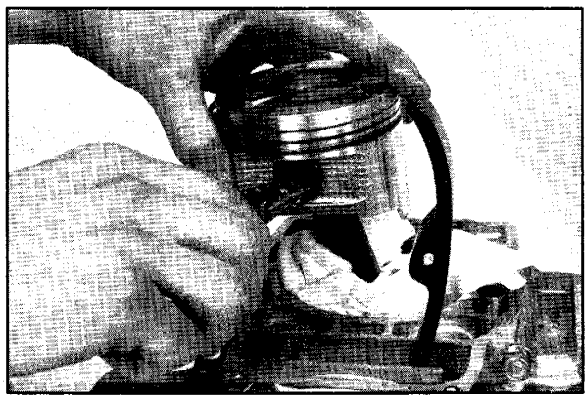


7. Tap cylinder lightly with a plastic hammer in the reinforced areas only until loose.
8. Rock cylinder forward and backward and lift it from the crankcase, supporting piston and connecting rod. Support piston with piston support block PN 2870390.
9. Remove dowel pins from crankcase.



Piston Removal

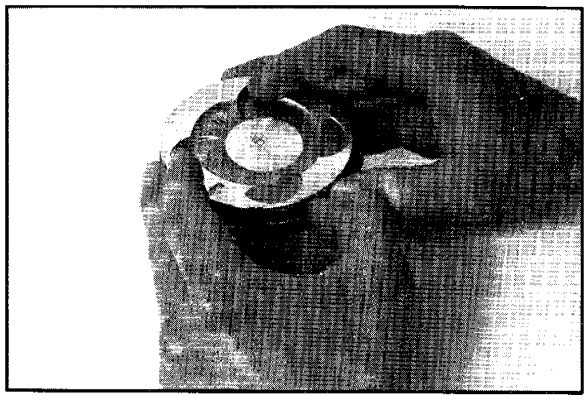
1. Note piston directional arrow pointing toward the Magneto (right) side of the engine.
2. Remove piston circlip and push piston pin out of piston. If necessary, heat the crown of the piston *slightly* with a propane torch. **CAUTION:** Do not apply heat to the piston rings. The ring may lose radial tension.
3. Remove top compression ring.



Engine Disassembly, Cont.

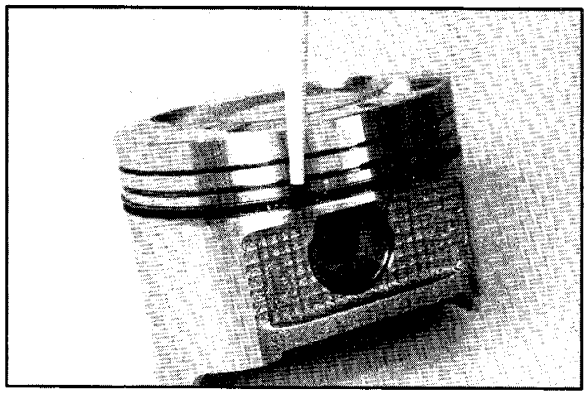
***Using a piston ring pliers**: Carefully expand ring and lift it off the piston. **CAUTION:** Do not expand the ring more than the amount necessary to remove it from the piston, or the ring may break.
***By hand:** Placing both thumbs as shown, spread the ring open and push up on the opposite side. Do not scratch the ring lands.

4. Repeat procedure for second ring.



The oil control ring is a three piece design consisting of a top and bottom steel rail and a center expander section. The top rail has a locating tab on the end which fits into a notch in the upper oil ring land of the piston.

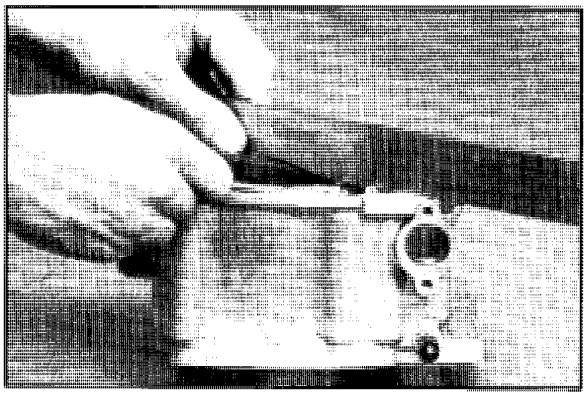
5. Remove the top rail first followed by the bottom rail.
6. Remove the expander.



Cylinder Inspection

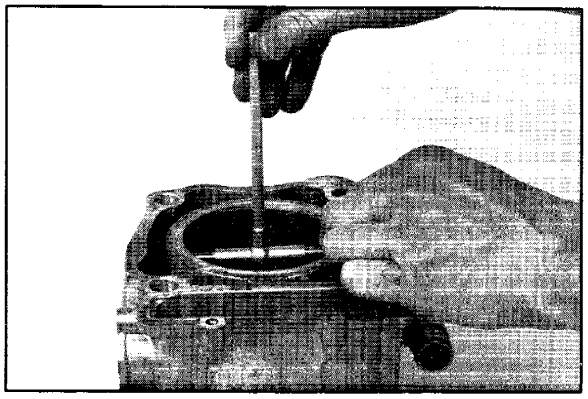
1. Remove all gasket material from the cylinder sealing surfaces.
2. Inspect the top of the cylinder for warpage using a straight edge and feeler gauge.

Cylinder Warpage:
.002″ (.05 mm)



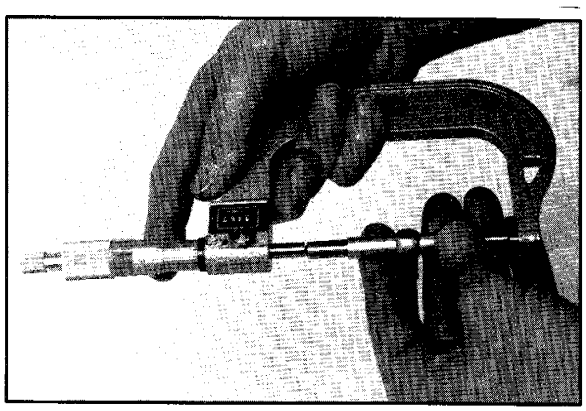
3. Inspect cylinder for wear, scratches, or damage.

4. Inspect cylinder for taper and out of round with a telescoping gauge or a dial bore gauge. Measure in two different directions, front to back and side to side, on three different levels (1/2″ down from top, in the middle, and 1/2″ up from bottom).



Engine Disassembly, Cont.

2. Record measurements. If cylinder is tapered or out of round beyond .002, the cylinder must be re-bored oversize, or replaced.



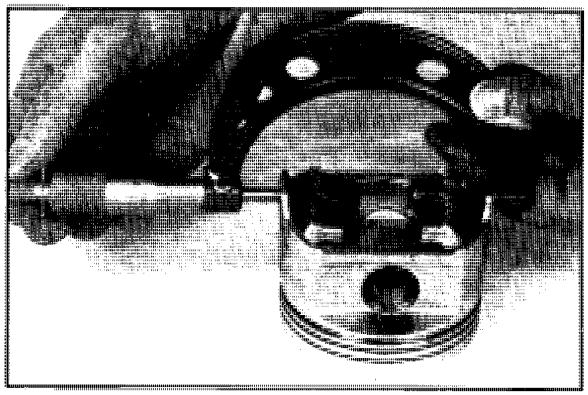
Cylinder Taper
Limit: .002 Max.

Cylinder Out of Round
Limit: .002 Max.

Standard Bore Size:
EH42PL
3.4606-3.4614 (87.90-87.92 mm)
EH50PL
3.6216-3.6224 (91.99-92.01 mm)

Piston to Cylinder Clearance

1. Measure piston outside diameter at a point 5 mm up from the bottom of the piston at a right angle to the direction of the piston pin.
2. Subtract this measurement from the maximum cylinder measurement obtained in step 5 above.



Piston to Cylinder Clearance

Std: .0006-.0018 (.015-.045 mm)

Limit: .0024 (.060 mm)

Boring Limit: .020 (.5 mm)

Piston O.D.:

EH42PL
Std: 3.4596-3.4600 (87.87-87.89 mm)

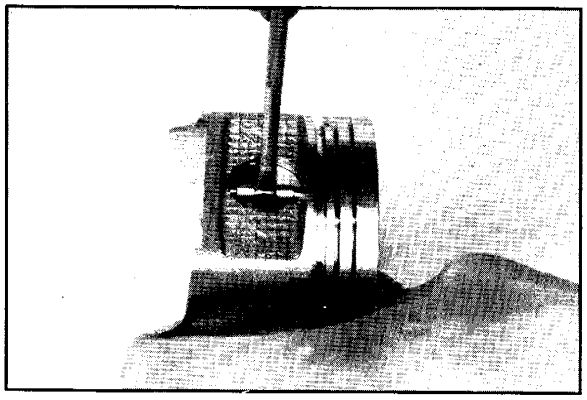
EH50PL
Std: 3.6205-3.6213 (91.96-91.98 mm)

Engine Disassembly, Cont.

3. Measure piston pin bore.

Piston Pin Bore:

Std: .9055-.9057 (23.00-23.006 mm)

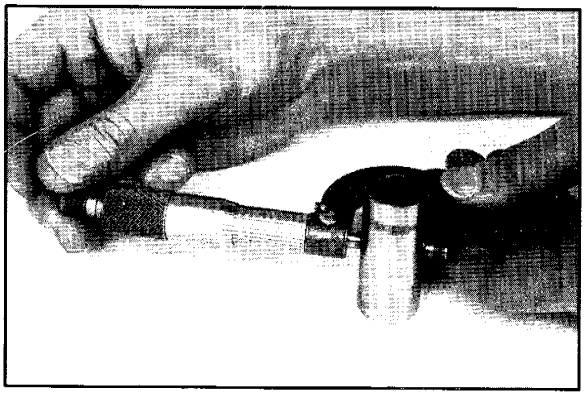


4. Measure piston pin O.D. Replace piston and/or piston pin if out of tolerance.

Piston Pin O.D.: .9063-.9055 (22.994-23.00 mm)

Std. Clearance Piston Pin to Pin Bore: .0002-.0003 (.004-.008 mm)

Degree of Fit: Piston Pin Must Be Fitted Into Position With Thumb at 20° C (68° F)



5. Measure connecting rod small end ID.

Connect Rod Small End ID:

.9058-.9063 (23.007-23.020 mm)

6. Measure piston ring to groove clearance by placing the ring in the ring land and measuring with a thickness gauge. Replace piston and rings if ring-to-groove clearance exceeds service limits.

Clearance Between Piston Ring and Piston Ring Groove

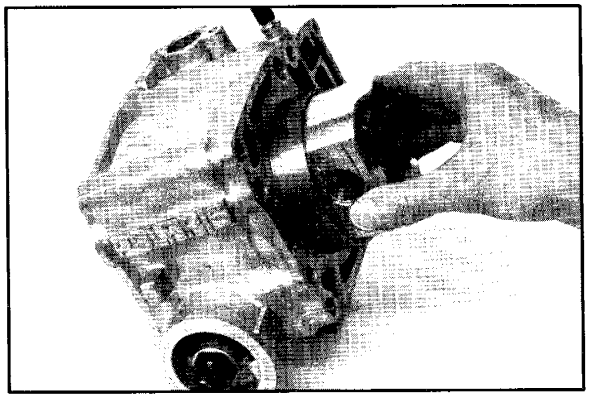
Top Ring
Std: .0016-.0031 (.040-.080 mm)
Limit: .0059 (.15 mm)

Second Ring
Std: .0012-.0028 (.030-.070 mm)
Limit: .0059 (.15 mm)

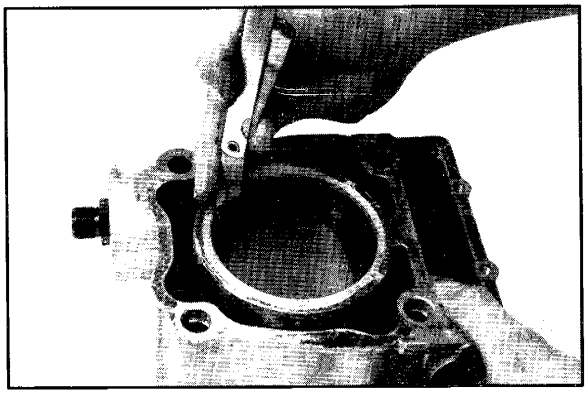
Engine Disassembly, Cont.

Piston Ring Installed Gap

1. Place each piston ring inside cylinder using piston to push ring squarely into place.



2. Measure installed gap with a feeler gauge at both the top and bottom of the cylinder. **NOTE:** A difference in end gap indicates cylinder taper. The cylinder should be measured for excessive taper and out of round.
3. If the *bottom* installed gap measurement exceeds the service limit, replace the rings.



NOTE: Always check piston ring installed gap after reboring a cylinder or when installing new rings. A rebored cylinder should always be scrubbed thoroughly with hot soapy water, rinsed, and dried completely. Wipe cylinder bore with an oil rag immediately to remove residue and prevent rust.

Piston Ring Installed Gap

Top Ring
Std: .0079-.0138 (.20-.36 mm)
Limit: .039 (1.0 mm)

Second Ring
Std: .0079-.0138 (.20-.36 mm)
Limit: .039 (1.0 mm)

Oil Ring
Std: .0079-.0276 (.20-.70 mm)
Limit: .059 (1.5 mm)

Crankcase Disassembly

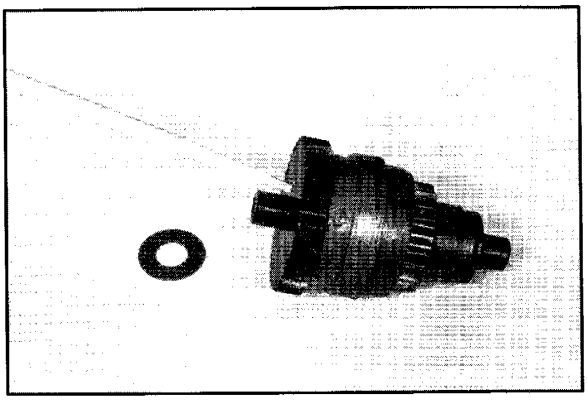
NOTE: Engine must be removed from frame to disassemble crankcase. Refer to engine removal, pages 3.38 - 3.42. Remove the following components: cylinder head, cylinder, water pump impeller.

NOTE: The recoil starter, starter motor, starter drive, flywheel, stator, cam chain and sprockets can be serviced with the engine in the frame.

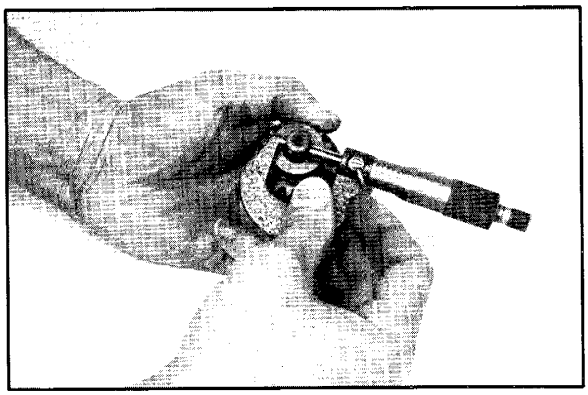
Engine Disassembly, Cont.

Starter Drive Removal/Inspection

1. Remove recoil housing bolts and remove housing.
2. Remove starter drive assembly. Note the thrust washer located at the rear of the drive mechanism.
3. Inspect the thrust washer for wear or damage and replace if necessary.



4. Measure the OD of the starter drive shaft on both ends and record.
5. Measure the ID of the bushing in the recoil housing and in the crankcase and record. Measure in two directions 90° apart to determine if bushing is out of round. Calculate bushing clearance. Replace bushing if clearance exceeds the service limit.



Std. Bushing ID:
.4735"-.4740" (11.11-12.04 mm)

Std. Shaft OD:
.470"-.472" (11.93-11.99 mm)

Starter Drive Bushing Clearance:
Std: .0015"-.004" (.038-.102 mm)

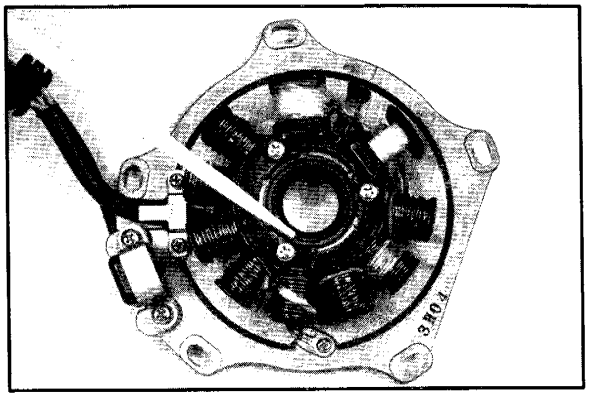
Service Limit:
.008" (.203 mm)

6. Inspect gear teeth on starter drive. Replace starter drive if gear teeth are cracked, worn, or broken.

Engine Disassembly, Cont.

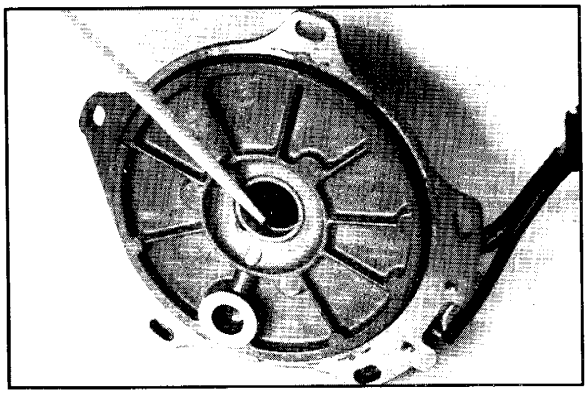
Flywheel/Stator Removal/Inspection

1. Remove flywheel nut and washer.
2. Install flywheel puller (PN 2870159) and remove flywheel. **CAUTION:** Do not thread the puller bolts into the flywheel more than 1/4″ or stator coils may be damaged.
3. Mark or note position of stator plate on crankcase.
4. Remove bolts and carefully remove stator assembly, being careful not to damage crankshaft bushing or oil seal on stator plate.
5. Remove oil passage O-Ring.
6. Remove large sealing O-Ring from outer edge of stator plate.



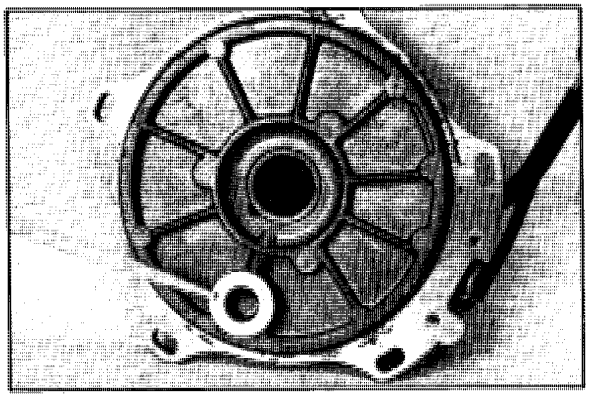
Cam Chain/Tensioner Blade

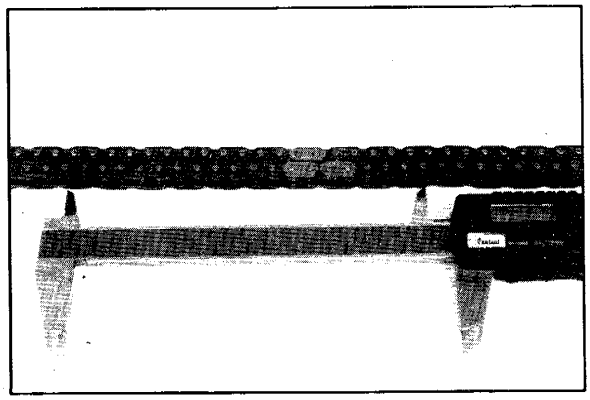
1. Remove bolt securing tensioner blade to crankcase.
2. Remove blade and inspect for cracks, wear, or damage.



3. Remove cam chain. Inspect chain for worn or missing rollers or damage. Stretch chain tight on a flat surface and apply a 10 lb. (4.53 kg) load. Measure length of a 20 pitch section of chain. Replace if worn past service limit.

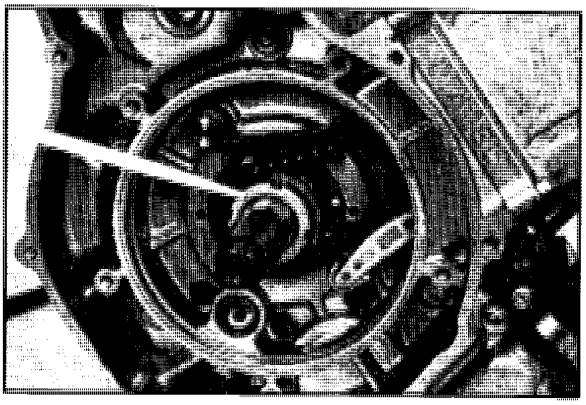
Chain Service Limit:
5.407″ (13.7 cm)





Engine Disassembly, Cont.

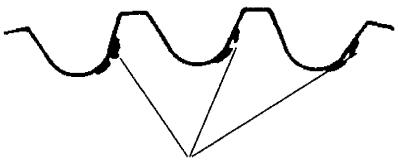
4. Using the special socket, remove the crankshaft slotted nut. **NOTE:** The slotted nut is a left hand thread.
5. Remove cam chain drive sprocket and Woodruff key from crankshaft.
6. Inspect sprocket teeth for wear or damage.
7. Inspect Woodruff key for wear.
8. Replace any worn or damaged parts.



One Way Valve

The one way valve prevents oil from draining out of the oil tank and into the crankcase when the engine is off. It must be clean and have adequate spring pressure in order to seal properly.

1. Remove cap bolt, sealing washer, spring, and one way valve from PTO side crankcase.

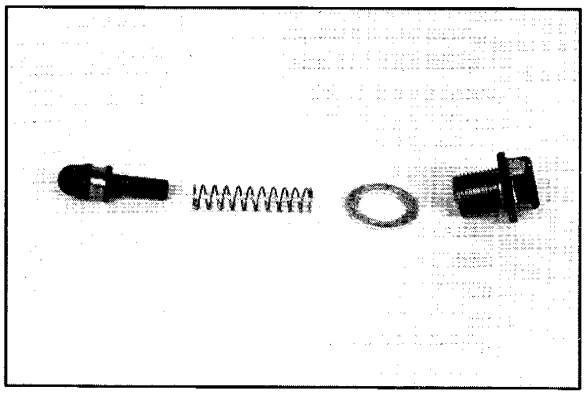


Inspect for Areas of Tooth Wear or Damage

2. Inspect free length of spring and check coils for distortion.

One Way Valve Spring Free Length:

Std: 1.450" (3.68 cm)



3. Inspect valve for wear.
4. Check seat area for nicks or foreign material that may prevent proper sealing of valve.

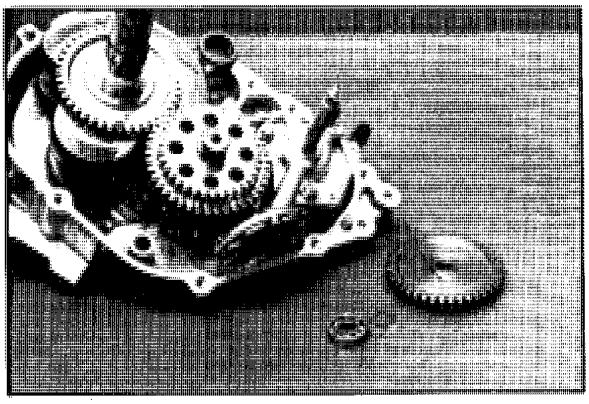
Crankcase Separation

1. Remove flange bolts (10) from magneto side crankcase evenly in a criss-cross pattern.
2. Install crankcase puller tool on magneto side crankcase with hole positioned over balancer gear. **NOTE:** The flywheel key must be removed before puller is installed.
3. Separate crankcase by tightening puller bolt in small steps and tapping on the pump shaft lightly with a plastic hammer.
4. Tap lightly on balancer gear with a brass drift through the hole in the puller if necessary to ensure the balancer shaft stays in the PTO side crankcase.
5. Continue to tighten puller center bolt while tapping on pump shaft and balancer shaft until cases are separated.

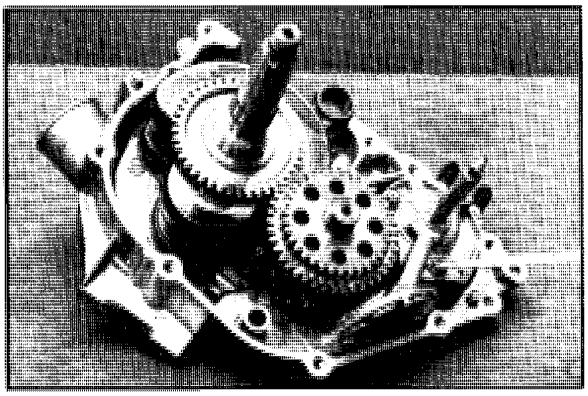
Engine Disassembly, Cont.

Oil Pump Removal/Inspection

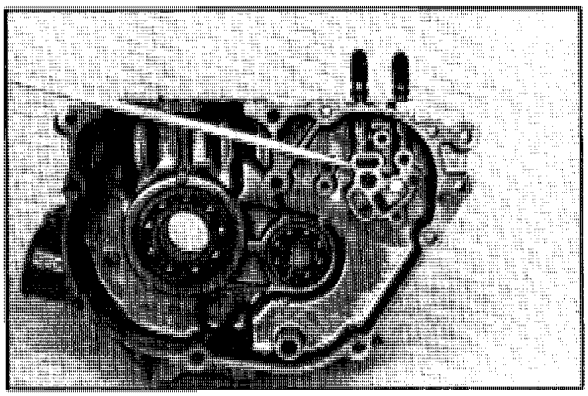
1. Remove thrust washer from pump shaft.
2. Remove pump drive gear.
3. Inspect drive gear teeth for cracks, damage or excessive wear.



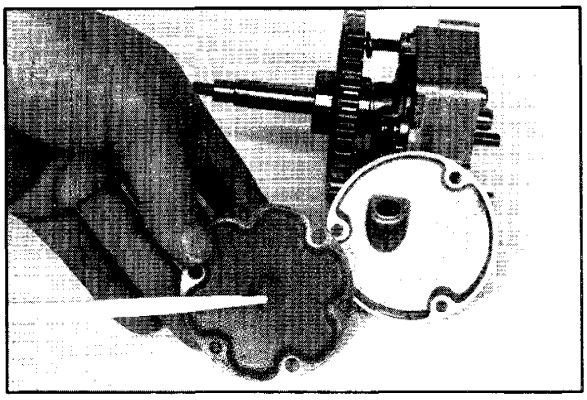
4. Remove three oil pump retaining bolts and pump.



5. Inspect mating surface of crankcase and oil pump. Check for nicks, burrs, or surface irregularities.

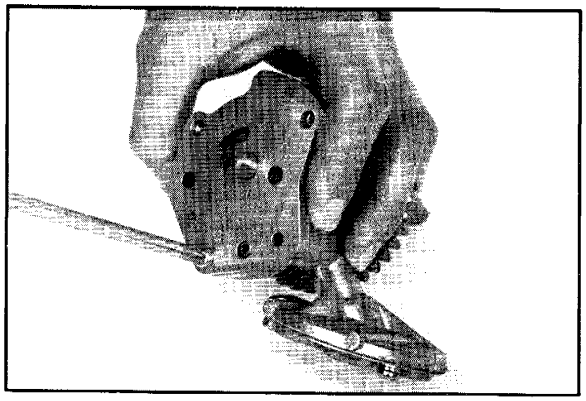


6. Remove the three screws and strainer screen from pump.
7. Clean screen thoroughly.

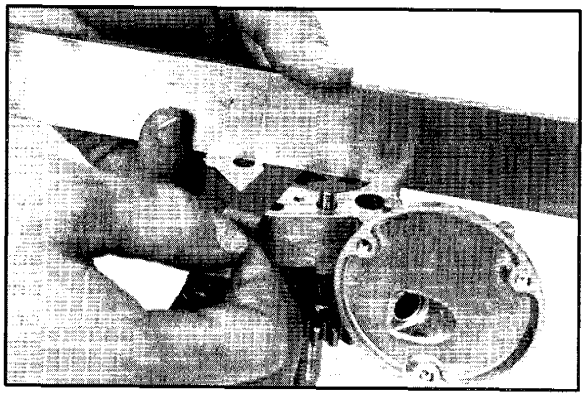


Engine Disassembly, Cont.

8. Remove pump body screw and feed chamber cover.



9. Measure pump end clearance using a thickness gauge and straight edge.

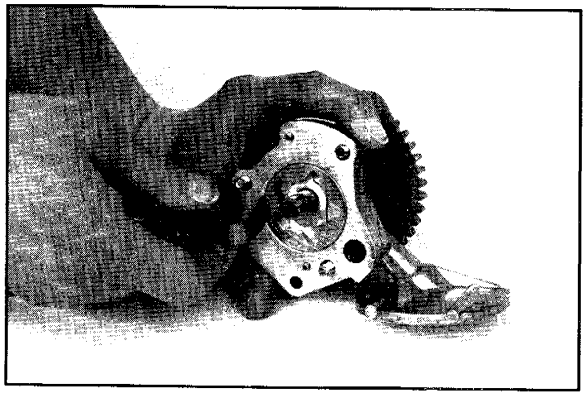


Pump End Clearance:

Std: .001-.003 (.0254-.0762 mm)

Wear Limit: .004 (.1016 mm)

10. Measure clearance between outer feed rotor and pump body with a thickness gauge.

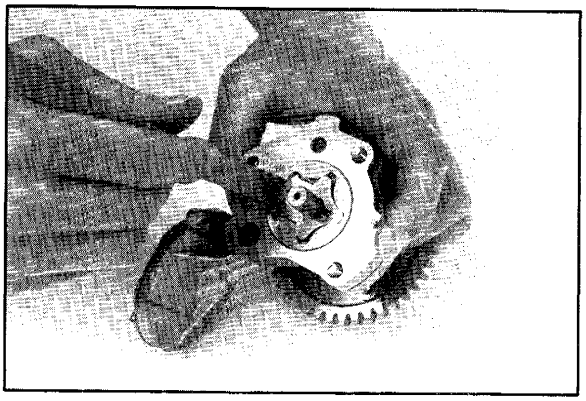


Outer Feed Rotor to Pump Body Clearance:

Std: .001-.003 (.0254-.0762 mm)

Wear Limit: .004 (.1016 mm)

11. Measure rotor tip clearance with a thickness gauge.



Rotor Tip Clearance:

Std: .005 (.127 mm)

Wear Limit: .008 (.2032 mm)

12. Remove inner and outer feed rotor and pump chamber body.
13. Repeat measurements for scavenge rotor.
14. Remove inner and outer scavenge rotor and inspect pump shaft for wear.

Engine Disassembly, Cont.

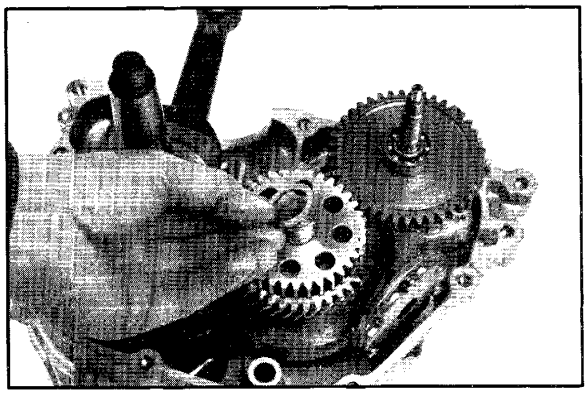
Oil Pump Assembly

1. Clean and dry all parts thoroughly. Apply clean engine oil to all parts. *Do not* use gasket sealer on the pump body mating surfaces or oil passages will become plugged.
2. Install pump shaft and scavenge rotor drive pin.
3. Install outer scavenge rotor, inner scavenge rotor, and scavenge casing.
4. Install outer feed rotor and inner feed rotor drive pin.
5. Install inner feed rotor and feed chamber cover with screw.
6. Tighten screw securely.
7. Install screen on pump body.
8. Install oil pump on crankcase and torque bolts to 6 ft. lbs. (.828 kg-m).

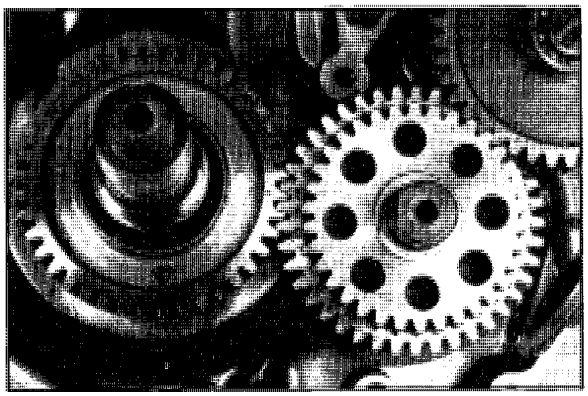
Oil Pump Attaching Bolt Torque:
6 ft. lbs. (.828 kg-m)

Counter Balancer Shaft Removal/Inspection

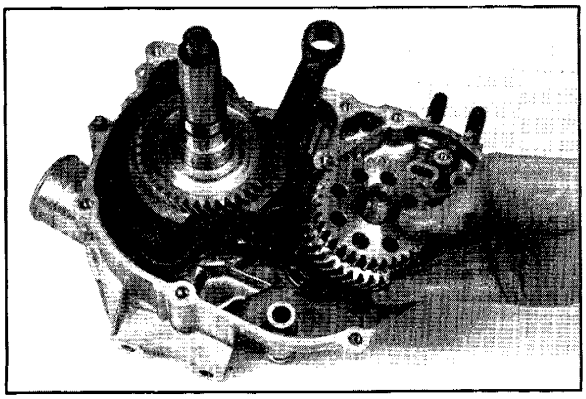
1. Remove the shim washer from the counter balancer shaft.



2. Note the alignment dots on the balancer and crankshaft gears, the marks must be aligned during reassembly.



3. Remove the balancer shaft from the crankcase.



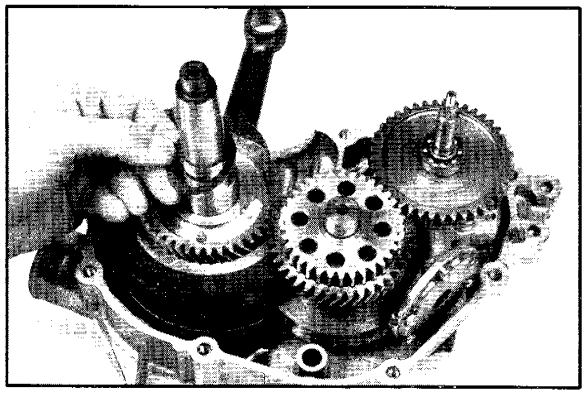
Engine Disassembly, Cont.

4. Inspect the balancer drive gear and pump shaft drive gear.
5. Replace the shaft if gear teeth are abnormally worn or damaged.
6. Inspect the balancer shaft bearings.

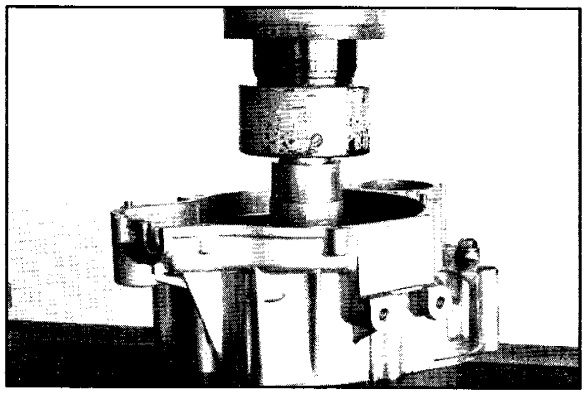
NOTE: Due to extremely close tolerances and minimal wear, the balancer shaft ball bearings must be inspected visually and by feel. Look for signs of discoloration, scoring or galling. Turn the inner race of each bearing. The bearings should turn smoothly and quietly. The outer race of each bearing should fit tightly in the crankcase. The inner race should be firm with minimal side to side movement and no detectable up and down movement.

Crankshaft Removal/Inspection

1. Remove the shim washer from the crankshaft.



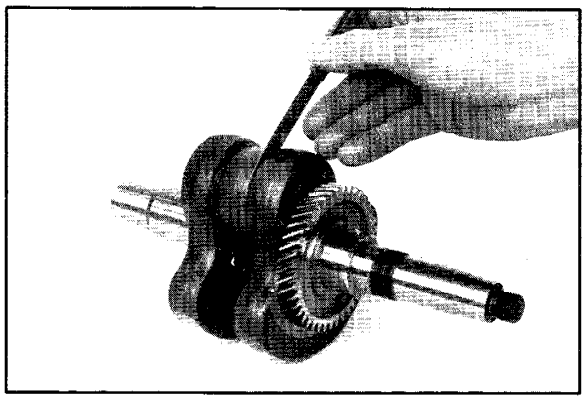
2. Support the PTO side crankcase and crankshaft; press the crankshaft out. Be careful not to damage the crankcase mating surface or connecting rod.



3. Use a thickness gauge to measure the connecting rod big end side clearance.

Connecting Rod Big End Side Clearance:

Std: .0039-.0256 (.1-.65 mm)
Limit: .0315 (.80 mm)



Engine Disassembly, Cont.

4. Place the crankshaft in a truing stand or V-blocks and measure the runout on both ends with a dial indicator.

Runout: .0024" (.06 mm)

5. Measure the connecting rod big end radial clearance.

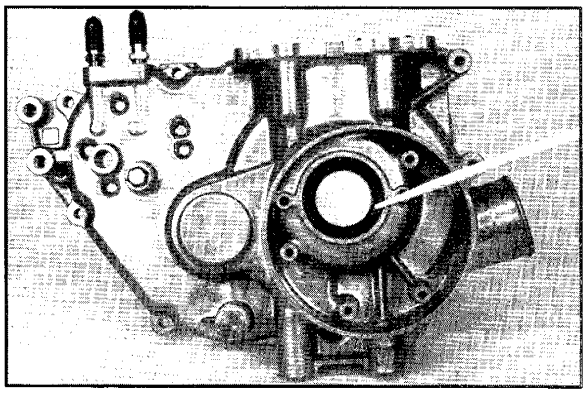
Big End Radial Clearance:

Std. .0004-.0015" (.011-.038 mm)
Limit .002" (.05 mm)

6. Inspect the crankshaft main bearing journals for scoring and abnormal wear.

Crankcase Bearing Inspection

1. Remove the seal from the PTO side crankcase.
2. Inspect the crankshaft main bearings, balancer shaft bearings, and pump shaft bearing.



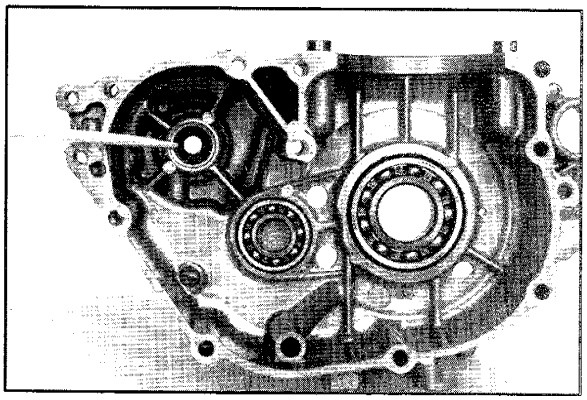
NOTE: Due to extremely close tolerances and minimal wear, the bearings must be inspected visually, and by feel. Look for signs of discoloration, scoring or galling. Turn the inner race of each bearing. The bearings should turn smoothly and quietly. The outer race of each bearing should fit tightly in the crankcase. The inner race should be firm with minimal side to side movement and no detectable up and down movement.

3. Support the crankcase and drive or press the main bearings out of each crankcase.
4. To remove balancer shaft bearings and pump shaft bearing use a blind hole bearing puller.

NOTE: Bearings are stressed during the removal process and *should not* be re-used!

Pump Shaft Oil Seal/ Water Pump Mechanical Seal Removal

Replace the pump shaft seal and water pump mechanical seal whenever the crankcase is disassembled.



1. Remove the pump shaft bearing from the Magneto (right hand) side crankcase.
2. Pry out the oil seal, noting the direction of installation. See page 3.76 for seal installation.
3. Drive the water pump mechanical seal out of the crankcase from inside to outside. Note: The new mechanical seal must be installed after the crankcases are assembled. See Mechanical Seal Installation, page 3.77.

Assembly

Crankcase Assembly

1. Remove all traces of gasket sealer from the crankcase mating surfaces. Inspect the surfaces closely for nicks, burrs or damage.
2. Check the oil pump and oil gallery mating surfaces to be sure they are clean and not damaged.

Bearing Installation

NOTE: To ease bearing installation, warm the crankcase until hot to the touch. Place the bearings in a freezer.

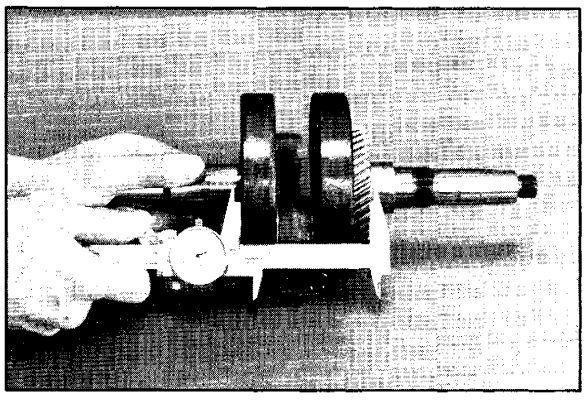
1. Install the bearings so the numbers are visible.
2. Drive or press new bearings into the crankcases, using the proper driver. **CAUTION:** Press only on outer race of bearing to prevent bearing damage.
   - 70mm (2.755″) driver- For crankshaft main bearings.
   - 46mm (1.810″) For counter balancer bearings.
   - 28mm (1.100″) For pump shaft bearing.

End Play Inspection/Adjustment

Before reassembling the crankcase,the following steps should be performed to determine the amount of crankshaft, counter balancer shaft, and pump shaft end play. Excessive end play may cause engine noise at idle and slow speeds. Too little play will side load the bearings which may lead to premature bearing failure.

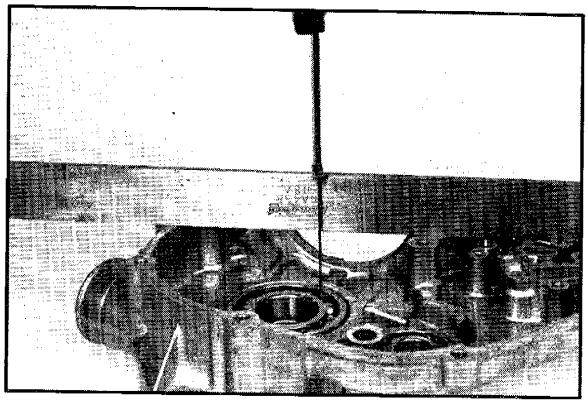
Crankshaft

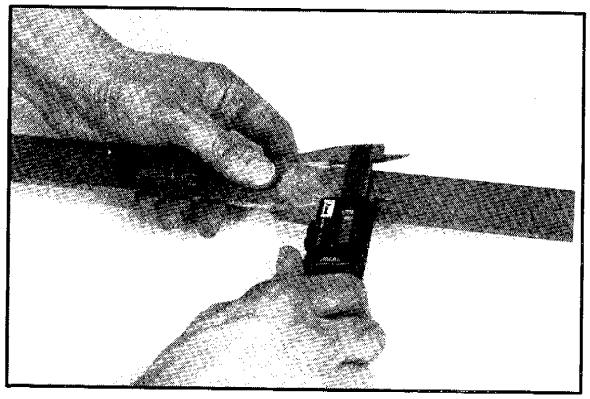
1. Make sure all bearings are firmly seated in the crankcase.
2. Measure the width of the crankshaft at the bearing seats with a dial caliper or micrometer, and record reading.



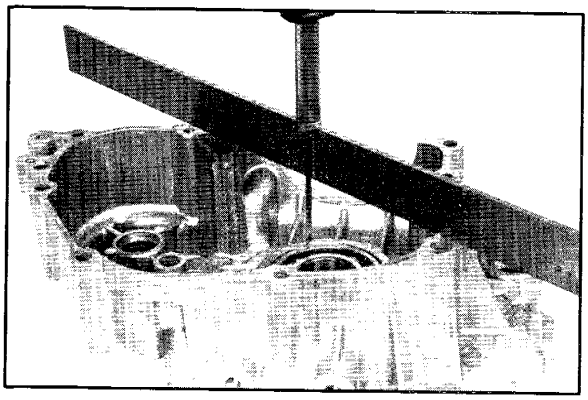
Assembly, Cont.

3. Measure the distance from the PTO crankcase mating surface to the main bearing using a dial caliper and a straight edge. Subtract the thickness of the straightedge and record.





4. Measure the distance from the magneto crankcase mating surface to the main bearing using the same method. Remember to subtract the straightedge from the measurement, and record.
5. Add the readings obtained in step 3 and 4.
6. Subtract the crankshaft width measured in step 2 from the figure obtained in step 5.
7. Subtract the thickness of the existing shim from the result of step 6 to determine if a different shim is needed.



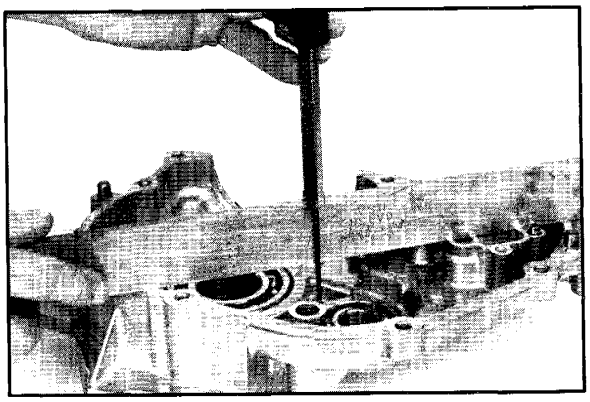
Crankshaft End Play:

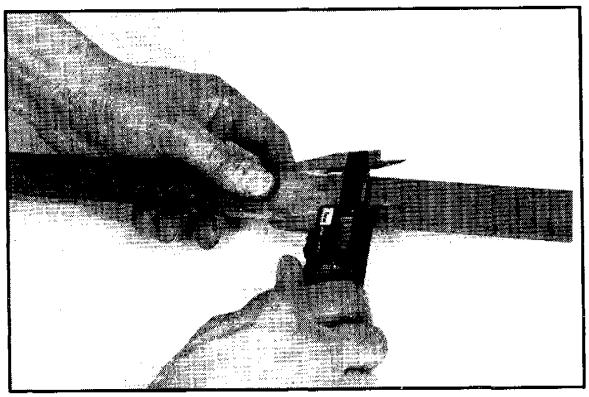
.008"-.016" (.02-.04 cm)

Assembly, Cont.

Counter Balancer

1. Make sure all bearings are firmly seated in the crankcase.
2. Measure the width of the counter balancer shaft at the bearing seats with a dial caliper or micrometer, and record reading.
3. Measure the distance from the PTO crankcase mating surface to the bearing using a dial caliper and a straight edge. Subtract the thickness of the straightedge and record.
4. Measure the distance from the magneto crankcase mating surface to the bearing using the same method.
5. Add the readings obtained in step 3 and 4.
6. Subtract the counter balancer shaft width measured in step 2 from the figure obtained in step 5.
7. Subtract the thickness of the existing shim from the result of step 6 to determine if a different shim is needed.





Counter Balancer Shaft End Play:

.008"-.016" (.02-.04 cm)

Pump Shaft

1. Make sure the pump shaft bearing is firmly seated in the Magneto side crankcase.
2. Measure the distance from the magneto crankcase mating surface to the bearing using a dial caliper and a straight edge. Subtract the thickness of the straightedge and record.
3. Install the gear on the oil pump and measure the width of the pump and gear. Subtract this measurement from the measurement recorded in step 2.
4. Subtract the thickness of the existing shim from the result of step 3 to determine if a different shim is needed.

Pump Shaft End Play:

.008"-.016" (.02-.04 cm)

Pump Shaft Oil Seal Installation

1. Install the seal from the outside of the crankcase (water pump side) with the spring facing inward, toward the pump shaft bearing.
2. Drive or press the seal into place using the 25mm (.985") seal driver, until flush with the bottom of the mechanical seal bore.
3. Lubricate the seal lip with grease.

Assembly, Cont.

Crankshaft, Counter Balancer, and Oil Pump Installation

Lubricate all bearings with clean engine oil before assembly. See engine disassembly photos (page 3.43-3.73) for reference.

Use the crankshaft installation tool kit PN 2871283 to prevent damage to the crankshaft and main bearings during installation.

1. Install the crankshaft into the PTO side crankcase. Screw the threaded rod into the crankshaft until the threads are engaged a minimum of one inch (25.4mm).
2. Install the collar, washer, and nut onto the threaded rod. Hold the crankshaft and tighten the nut to draw the crankshaft into the main bearings until fully seated. Loosen the nut and remove the threaded rod from the crankshaft. If removal is difficult, install two nuts on the end of the threaded rod and tighten against each other.
3. Install the proper shim on the magneto end of the crankshaft.
4. Place the balancer shaft in the PTO crankcase aligning the timing marks on the crankshaft and balancer gears. Install the proper shim washer on the shaft.
5. Inspect the oil pump sealing surface on the crankcase. Apply a light film of engine oil to the surface and install the oil pump.

NOTE: Do not use gasket sealer on the pump mating surfaces.

Oil Pump Bolt Torque:
6. ft. lbs. (.828 kg-m)

6. Align the drive gear with the drive pin on the pump shaft and install the gear. Be sure the gear is fully seated and properly engaged.
7. Install the proper shim washer on the pump shaft.

Crankcase Assembly

1. Apply 3 Bond 1215 (P/N 2871557) to the crankcase mating surfaces. Be sure the alignment pins are in place.
2. Set the crankcase in position carefully to avoid damaging the pump shaft seal, and install the magneto end crankshaft installation tool (follow instructions provided with tool kit PN 2871283). Draw the crankcase halves together by tightening the nut on the tool and tapping lightly in the pump shaft area with a soft faced hammer to maintain alignment. Continually check alignment of the cases during installation, closing the gap equally until the surfaces are tightly seated.
3. Remove the tool.
4. Install the crankcase flange bolts and tighten in 3 steps in a criss-cross pattern to specified torque.

Crankcase Bolt Torque:
14 ft. lbs. (1.932 kg-m)

Crankcase Sealant:
PN 2871557

Water Pump Mechanical Seal Installation

1. Clean the seal cavity to remove all traces of old sealer.
2. Place a new mechanical seal in the seal drive collar, and install on the pump shaft.
3. Screw the guide onto the end of the pump shaft.
4. Install the washer and nut and tighten to draw seal into place until fully seated.
5. Remove the guide adaptor using the additional nut as a jam nut if necessary.

Water Pump Mechanical Seal Removal - Engine Installed

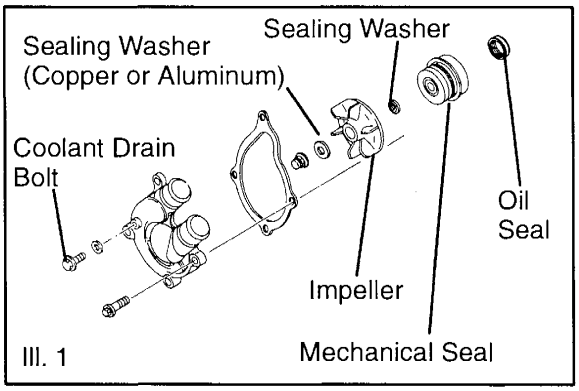
Water pump mechanical seal removal tool: 2872105

Replacement T-handle for 2872105: 2872106

This tool allows a technician to replace the mechanical water pump seal on EH42PL & EH50PL engines without removing the engine and splitting the cases.

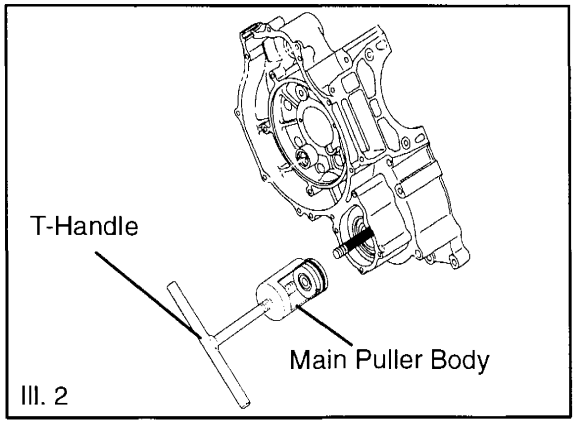
CAUTION: Improper or careless use of this tool or procedure can result in a bent water pump shaft. Pump shaft replacement requires engine removal and crankcase separation. Use caution while performing this procedure. Make sure that the puller is parallel to the shaft at all times. Do not place side loads on the water pump shaft or strike the puller or shaft in any way.

1. After the coolant has been drained, remove the water pump cover, impeller and the sealing washer. (Ill. 1)



Ill. 1

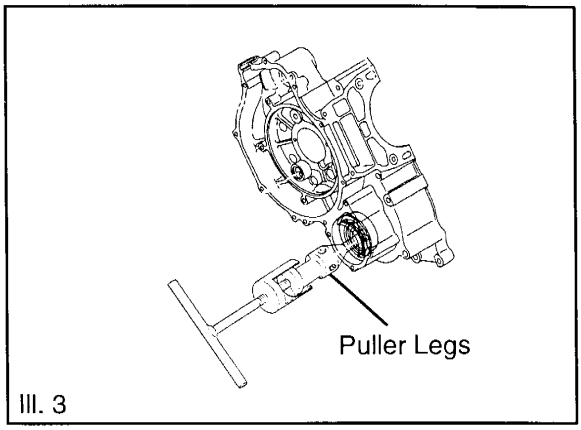
2. Slide the main puller body over the outer portion of the mechanical seal as shown in Ill. 2 and turn T-Handle clockwise until it contacts water pump shaft. Continue rotating until outer portion of mechanical seal is separated from the metal seal body.



Ill. 2

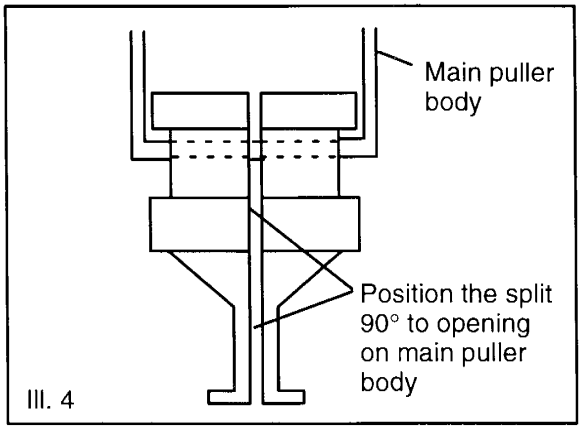
Water Pump Mechanical Seal Removal - Engine Installed, Cont.

3. Insert the puller legs between the water pump drive shaft and the remaining portion of the mechanical seal. Attach the puller legs to the main puller body. Ill. 3



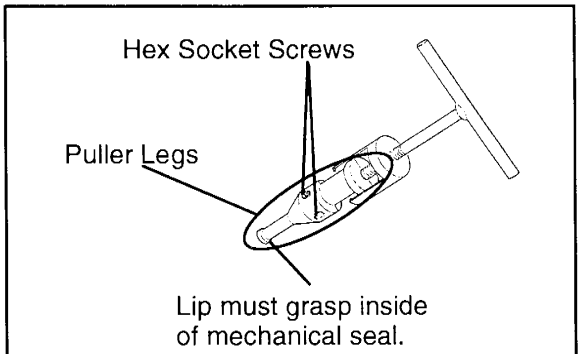
Ill. 3

4. Ensure that the split between the puller legs is fully supported by the main body of the tool (Ill 4).



Ill. 4

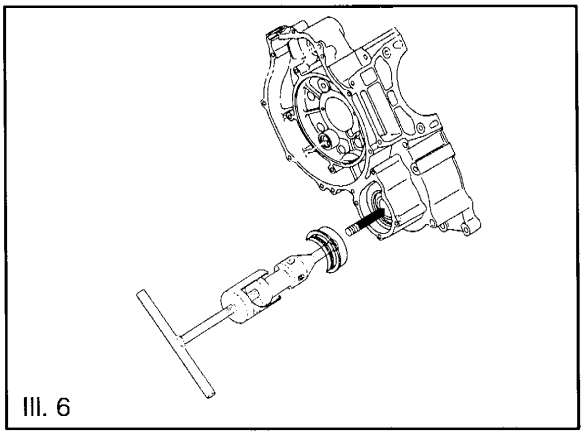
5. Tighten the hex socket screws on the puller legs sufficiently so the lip of the puller legs will grasp the mechanical seal. Ill. 5



Ill. 5

6. Turn the puller T-Handle clockwise until it contacts the water pump shaft. Continue rotating until the remaining portion of mechanical seal has been removed from the cases. Ill. 6 Pump shaft oil seal can also be replaced at this time if necessary.

7. Special tool (PN 5131135) is required to install the new mechanical seal. This tool is available separately and it is also included in the Crankshaft/Water Pump Seal Installation Kit (PN 2871283).


Ill. 6

Assembly, Cont.

One Way Valve Installation

Install the one way valve plunger, spring, and plug using a new sealing washer.

One Way Valve Plug Torque:
16 ft. lbs. (2.2 kg-m)

Cam Chain Drive Sprocket Installation

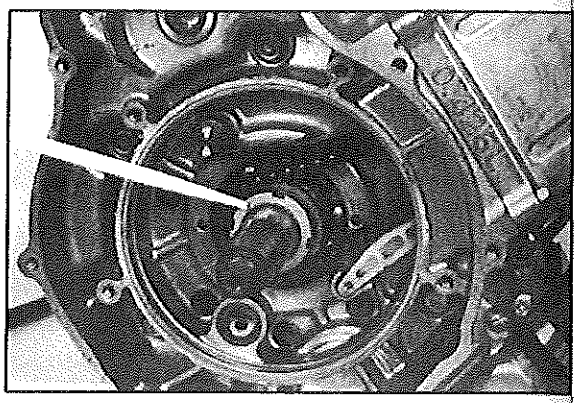
1. Install the Woodruff key, drive sprocket, and slotted nut. Tighten the nut to the specified torque.

Slotted Nut Torque:
35-51 ft. lbs. (4.71-6.86 kg-m)

Tensioner Blade Installation

1. Install the tensioner blade and tighten the mounting bolt to specified torque.

Tensioner Blade Mounting Bolt Torque:
6 ft. lbs. (.828 kg-m)

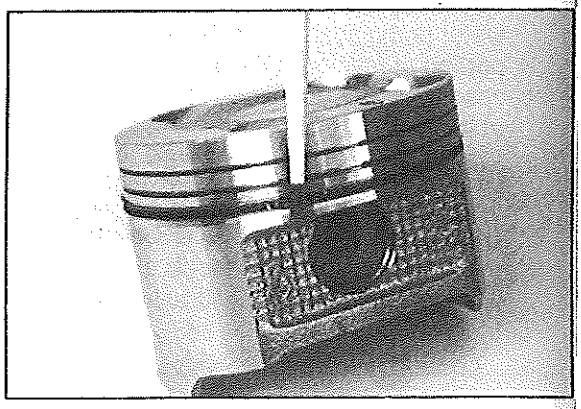


Piston Ring Installation

NOTE: Apply clean engine oil to all ring surfaces and ring lands. Always check piston ring installed gap before rings are installed on piston. See page 3.65. If the piston has been in service clean any accumulated carbon from the ring grooves and oil control ring holes.

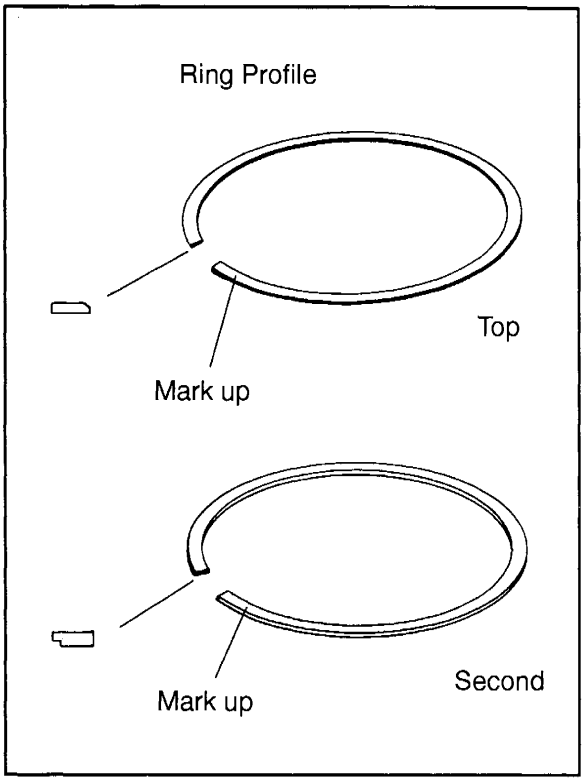
1. Place the oil control ring expander in oil ring groove with the end gap facing forward. The expander has no up or down marking and can be installed either way. The ends should butt squarely together and must not overlap.
2. Install the oil ring top rail.

NOTE: The top rail has a locating tab to prevent rotation. The tab must be positioned in the notch on the side of the piston as shown.



Assembly, Cont.

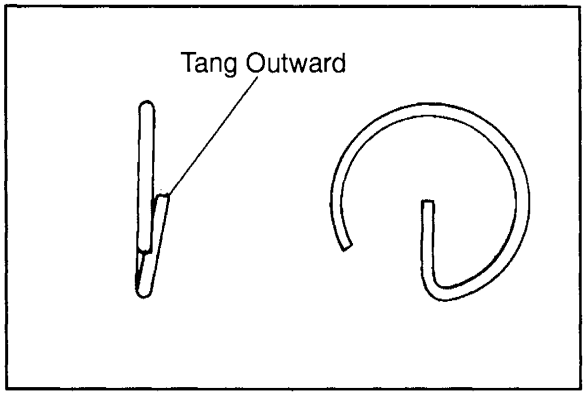
3. Install the bottom rail with the gap at least 30° from the end of the expander on the side opposite the top rail gap.(See Ill.).
4. Install the second ring with the "R" mark facing up. Position the end gap toward the rear (intake) side of the piston.
5. Install the top ring (chrome faced) with the "R" mark facing up and the end gap facing forward (toward the exhaust). (See Ill.).
6. Check to make sure the rings rotate freely in the groove when compressed.



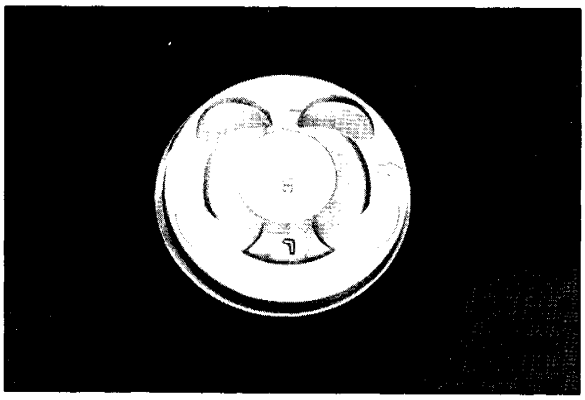
Piston Installation

1. Clean the gasket surfaces on the cylinder and crankcase. Remove all traces of old gasket material.
2. Make sure the cylinder mounting bolt holes are clean and free of debris.
3. Install a new circlip on one side of the piston with the end gap facing *up* or *down,* and tang outward.

CAUTION: Circlips become deformed during the removal process. Do not re-use old circlips. Do not compress the new clip more than necessary upon installation to prevent loss of radial tension. Severe engine damage may result if circlips are re-used or deformed during installation.

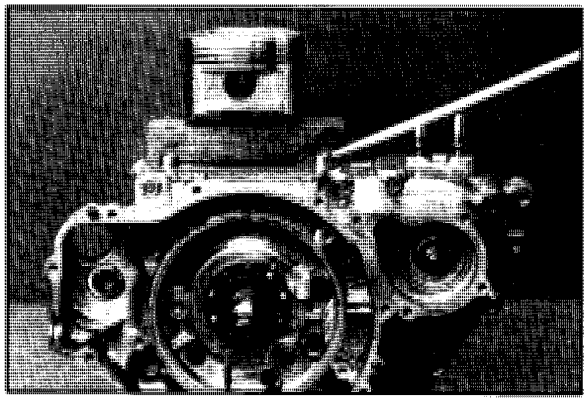


4. Apply clean engine oil to the piston rings, ring lands, piston pin bore, piston pin, and piston skirt. Lubricate the connecting rod (both ends), balancer drive gear, and crankshaft main bearing area.
5. Install the piston on the connecting rod with the arrow facing the magneto (RH) end of the crankshaft. The piston pin should be a push fit in the piston.
6. Install the other circlip with the gap facing up or down and tang outward. (See Caution with step 3 above). Push the piston pin in both directions to make sure the clips are properly seated in the groove.



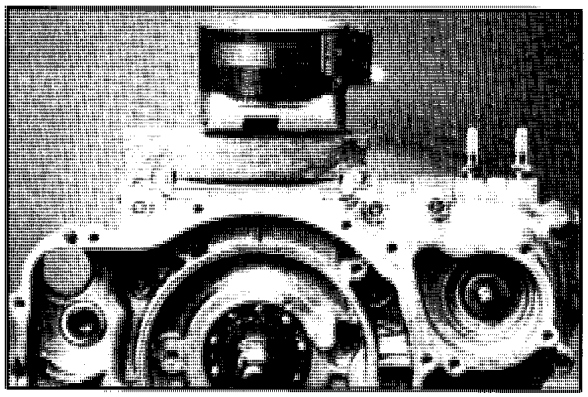
Assembly, Cont.

7. Place the dowel pins in the crankcase and install a new cylinder base gasket.

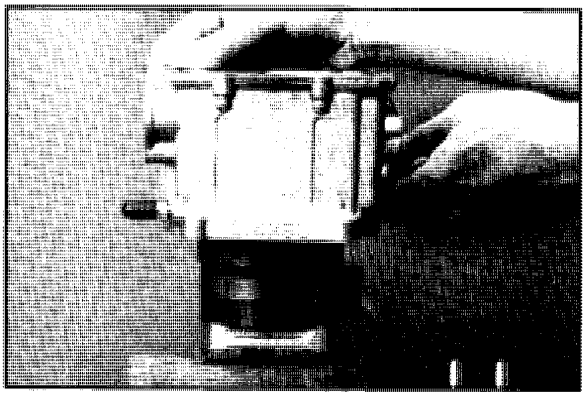


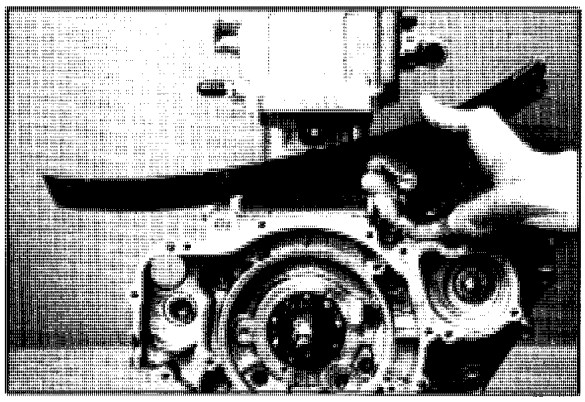
Cylinder Installation

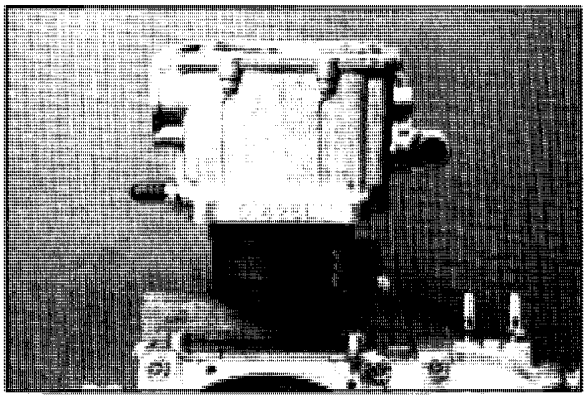
1. Position the piston support block PN 2870390 beneath the piston skirt to support the piston during cylinder installation.
2. Apply clean engine oil to the ring compressor (Snap On™ PN RCL30) and install the compressor following manufacturers instructions. **CAUTION:** Make sure the oil control ring upper rail tab is positioned properly in the notch of the piston. Verify all ring end gaps are correctly located.



3. Apply clean engine oil liberally to the cylinder bore and tapered area of the sleeve. Install the cylinder with a slight rocking motion until the rings are captive in the sleeve, and remove the ring compressor.







Assembly, Cont.

6. Push the cylinder downward until fully seated on the base gasket.

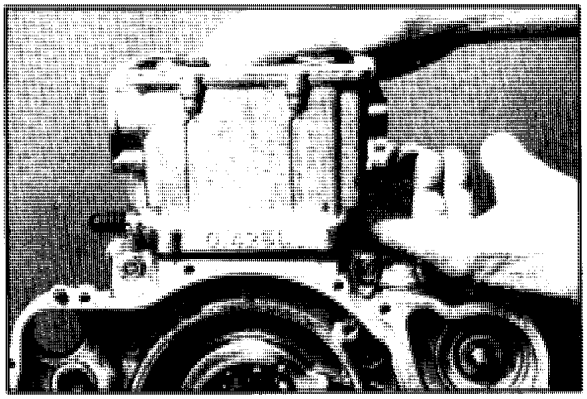
7. Apply a light film of oil to the threads and flange surface of the cylinder mounting bolts.

8. Install all four bolts finger tight. Rotate the engine and position the piston at BDC.

NOTE: If cam chain is installed, hold it up while rotating the engine to avoid damage to the chain, drive sprocket teeth, or tensioner blade.

9. Tighten the cylinder bolts in three steps in a criss cross pattern and torque to specifications.

10. Install the two 6mm bolts.



Cylinder Bolt Torque:

10mm - 46 ft. lbs. (6.348 kg-m)
6mm - 6 ft. lbs. (.828 kg-m)

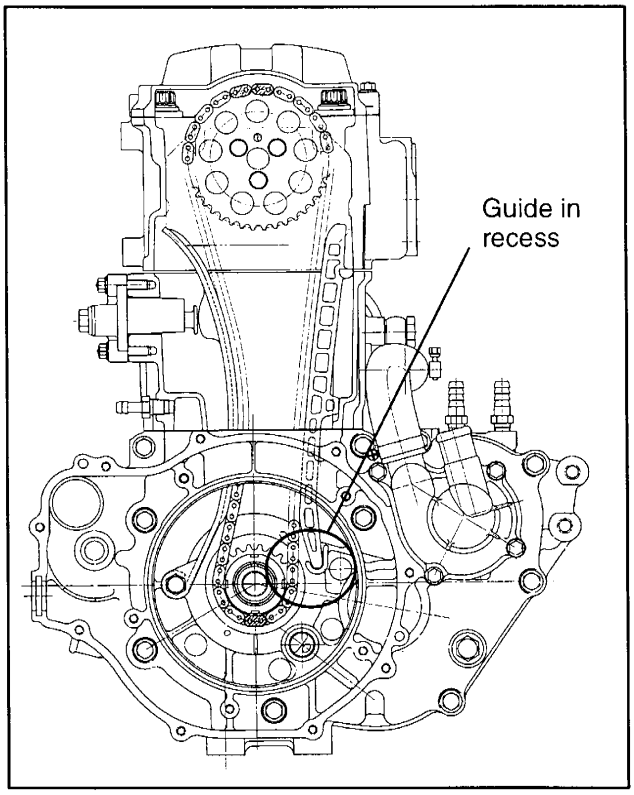
Cylinder Head Installation

Clean the gasket surfaces on the cylinder head and cylinder. Remove all traces of old gasket material.
Refer to disassembly photos.

1. Install the cam chain tensioner guide. Be sure bottom end of guide is located properly in crankcase.

2. Install the two dowel pins and a new cylinder head gasket.

3. Place the cylinder head on the cylinder. Apply a film of engine oil to the cylinder head bolt threads and washers, and hand tighten the bolts.



Assembly, Cont.

The following procedure must be used to torque the cylinder head properly:

Torque all bolts evenly in a criss cross pattern

***Torque bolts to 22 ft. lbs. (3.04 kg-m)**

***Torque bolts to 51 ft. lbs. (7.04 kg-m)**

***Loosen bolts evenly 180° (1/2 turn)**

***Loosen bolts again another 180° (1/2 turn)**

***Torque bolts to 11 ft. lbs. (1.52 kg-m)**

***From this point, tighten bolts evenly 90° (1/4 turn)**

***Finally, tighten another 90° (1/4 turn)**

***Install two 6mm bolts and torque to 6 ft. lbs. (.828 kg-m)**

Cam Chain/Camshaft Installation

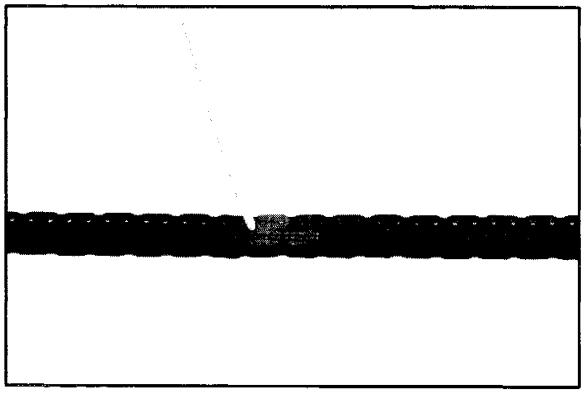
Install the cam chain over the crankshaft with the plated links facing outward.

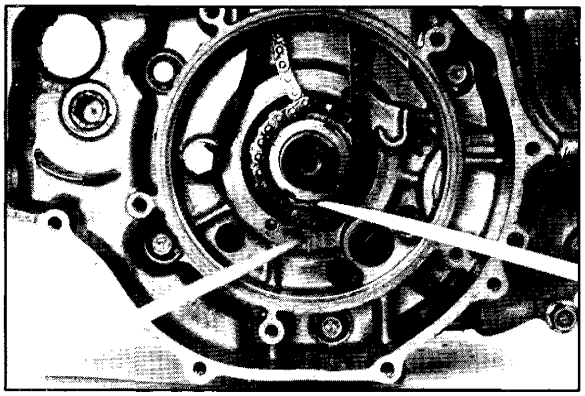
CAUTION: Serious engine damage may result if the camshaft is not properly timed to the crankshaft.

IMPORTANT CAMSHAFT TIMING NOTE: In order to time the camshaft to the crankshaft, the piston must be precisely located at Top Dead Center (TDC). This can be accomplished using one of two methods.

When the stator assembly is removed, follow the procedure outlined in Method 1. This method uses the cam chain plated links to time the camshaft and the dot on the cam chain drive sprocket to establish TDC (see Method 1, page 3.83). It is important to note that this method can only be used when the stator is removed and the cam chain drive sprocket is in view. The plated links *are not* used to time the camshaft when the flywheel is installed.

When the stator assembly is installed use Method 2. This method establishes accurate Top Dead Center (TDC) by aligning the single mark on the flywheel with the notch in the timing inspection hole (see Method 2, page 3.85). The camshaft sprocket alignment pin faces upward and directly in line with the crankshaft to camshaft centerline.





Assembly, Cont.

Camshaft Installation - Timing Method 1. Refer to Illustration, Page 3.84

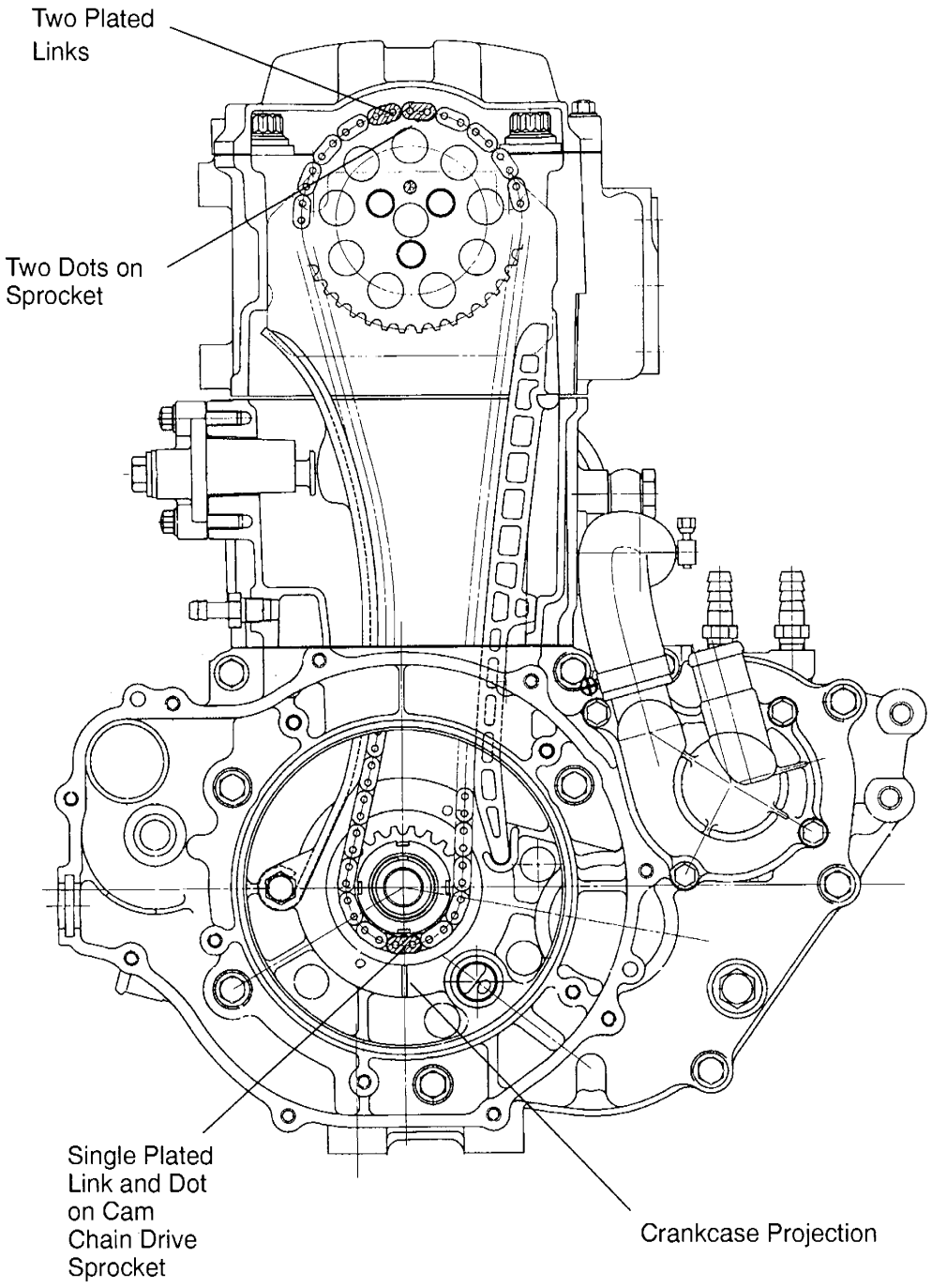
If the stator assembly is removed: **NOTE:** Use this method only when the stator is removed and cam chain drive sprocket is in view.

1. Rotate the crankshaft until the dot on the cam chain drive sprocket is aligned with the crankcase projection (dot facing downward).
2. Align the single plated link on the cam chain with the dotted tooth of the cam chain drive sprocket. Use a wire to pull the chain up through the cylinder and cylinder head, and secure it to hold the chain in place.
3. Apply Polaris Low Temp Grease PN 2870577, or moly grease to the camshaft main journals and cam lobes. Lubricate automatic compression release mechanism with clean engine oil. (To install the compression release mechanism, refer to page 3.48).
4. Install the camshaft with the lobes facing downward and the sprocket alignment pin facing upward.
5. Disconnect the wire from the cam chain and install the cam sprocket with the two dots facing outward.
6. Loop the cam chain over the cam sprocket, aligning the two plated links on the chain with the two dots on the sprocket.
7. Install the sprocket on the camshaft. Apply Loctite 242 to the cam sprocket bolts and torque to specifications.

Cam Sprocket Bolt Torque:
6 ft. lbs. (.828 kg-m)

8. Apply Loctite 515 or 518 Gasket Eliminator to the camshaft end cap and install using a new O-ring.
9. Check all cam timing marks to verify proper cam timing, and install the cam chain tensioner. See Cam Chain Tensioner Installation page 3.87. **NOTE:** The plated links will not align after engine is rotated.

Method 1 - Camshaft Timing with Stator Removed

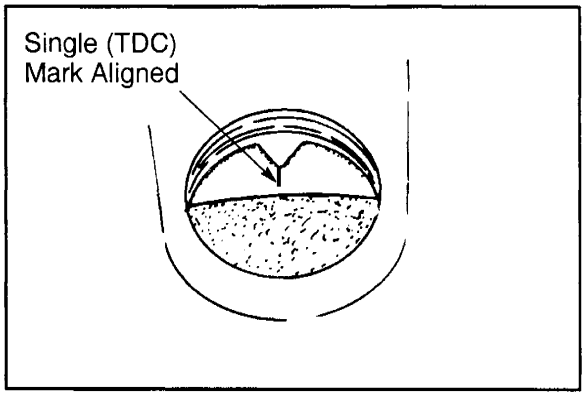


NOTE: Plated links will not align after engine is rotated.

Assembly, Cont.

Camshaft Installation - Timing Method 2. Refer to Illustration, Page 3.86

1. Apply Polaris Low Temp Grease PN 2870577, or molybdenum disulfide grease to the camshaft main journals and cam lobes. Lubricate automatic compression release mechanism with clean engine oil. (To install the compression release mechanism, refer to page 3.48).
2. Install the camshaft with the lobes facing downward and the sprocket alignment pin facing upward.
3. Disconnect the wire from the cam chain and rotate the engine to align the single (TDC) timing mark (Top Dead Center) on the flywheel with the notch in the timing inspection window. Be sure to use the *single* TDC mark when installing the cam. Do not use the advance marks. See Ill. on next page.
4. Loop the cam chain on the cam sprocket with the dots on the sprocket facing outward and the alignment pin notch facing directly upward.
5. Before positioning the sprocket on the camshaft, check the position of the cam sprocket alignment pin. When the cam is positioned properly, the cam sprocket alignment pin is directly in line with the crankshaft/camshaft centerline.
6. Install the sprocket on the camshaft. Apply Loctite 242 to the cam sprocket bolts and torque to specifications.

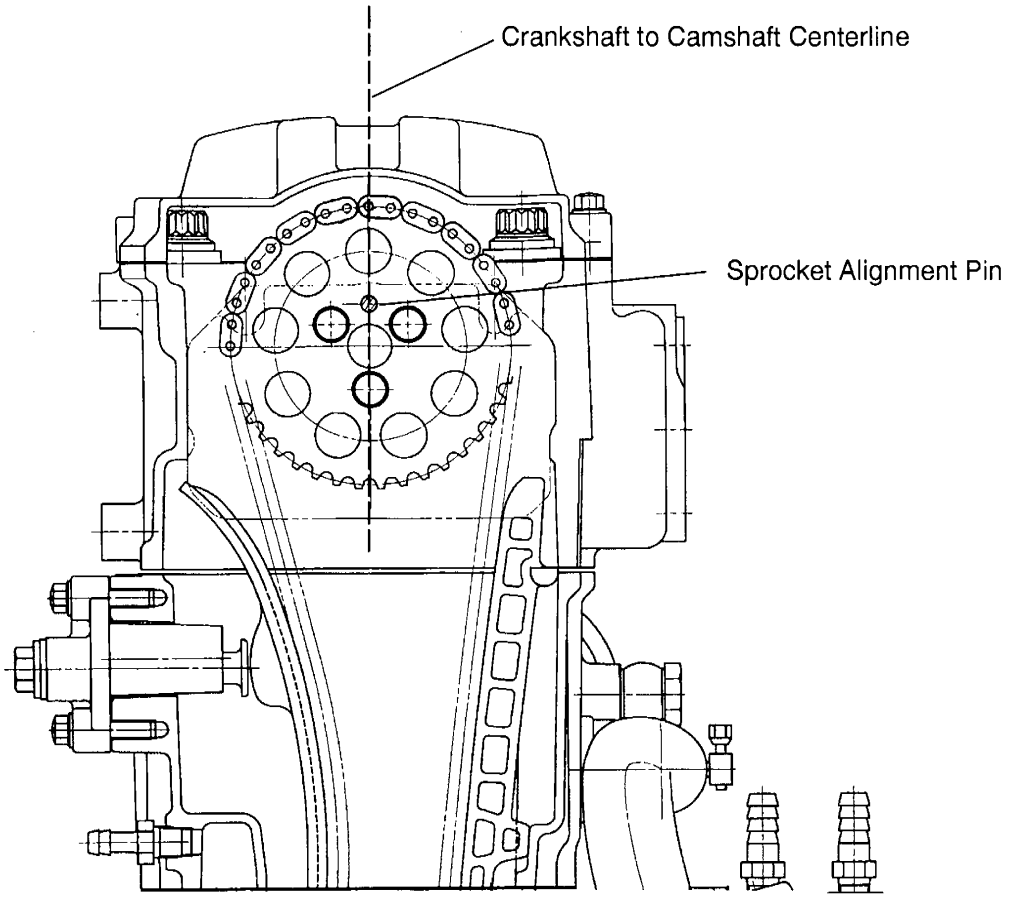


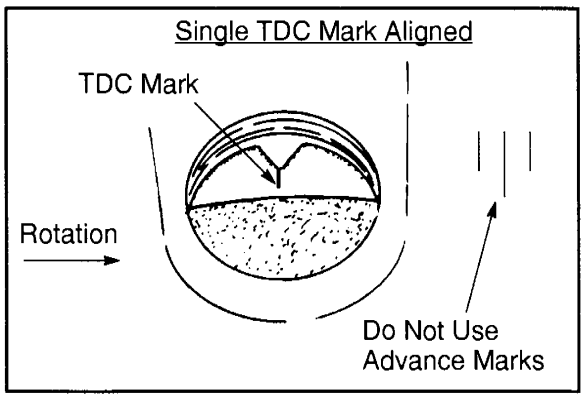
Cam Sprocket Bolt Torque:

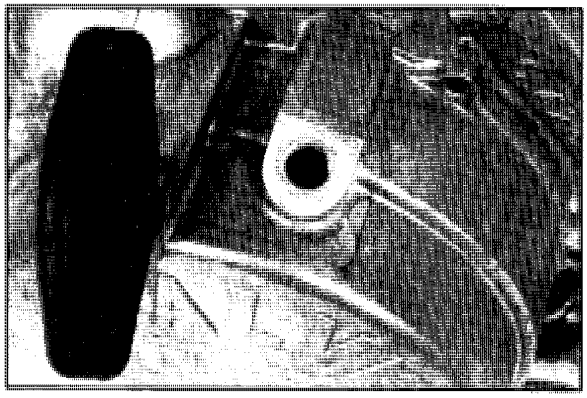
6 ft. lbs. (.828 kg-m)

7. Apply Loctite 515 or 518 Gasket Eliminator, or 3 Bond 1215 to the camshaft end cap and install using a new O-Ring.
8. Check all cam timing marks to verify proper cam timing, and install the cam chain tensioner body with a new gasket.
9. After tensioner installation, rotate engine at least two revolutions and re-check marks/timing.

Method 2 Camshaft Timing Using Flywheel TDC Mark





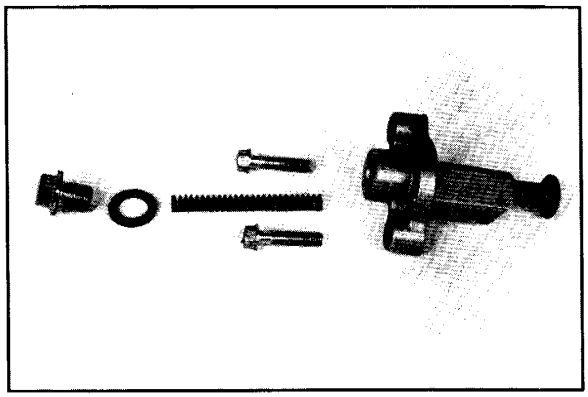


Recoil Housing Timing Inspection Hole

Assembly, Cont.

Cam Chain Tensioner Installation

1. Release the ratchet pawl and push the tensioner plunger all the way into the tensioner body.
2. Install the tensioner body with a new gasket and tighten the bolts.



Tensioner Bolt Torque:
6 ft. lbs. (.828 kg-m)

3. Install the spring, new sealing washer, and tensioner plug.

Tensioner Plug Torque:
17 ft. lbs. (2.346 kg-m)

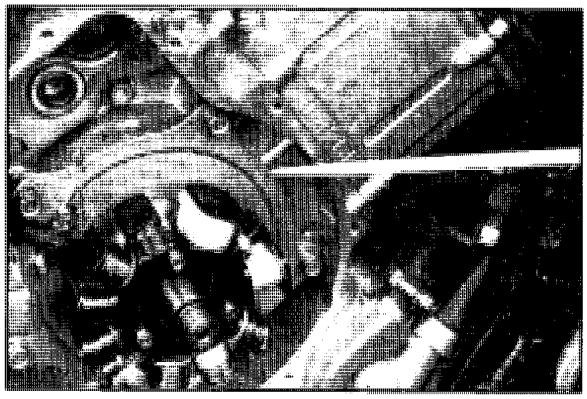
4. Slowly rotate engine two to three revolutions and re-check cam timing. **NOTE:** Plated links will not align after engine is rotated. Check crankshaft position by aligning dot on sprocket with crankcase projection (or TDC mark if flywheel is installed). Use cam sprocket locating pin (see Timing Method 2) to check camshaft position.

Stator, Flywheel and Starter Drive Installation

NOTE: The stator, flywheel, starter drive, and recoil can be assembled with the engine in the frame.

Stator

1. Apply a light film of grease to the crankshaft seal. Apply molybdenum disulfide grease or assembly lubricant to the crankshaft bushing.
2. Install a new O-Ring in the oil passage recess in the crankcase.
3. Apply 3 Bond 1215, Loctite 515 or 518, or an equivalent sealer to the stator plate outer surface and install a new O-Ring.
4. Install the stator plate being careful not to damage the seal. Align timing reference marks on the plate and crankcase. Be sure the plate is fully seated.



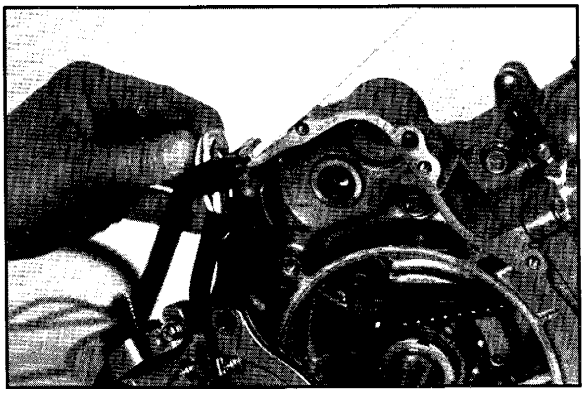
Assembly, Cont.

4. Torque bolts evenly to specification.

Stator Plate Bolt Torque:

5.1-6.5 ft. lbs. (.68-.88 kg-m)

5. Seal stator wire grommet with 3 Bond 1215 or equivalent sealer.



Flywheel

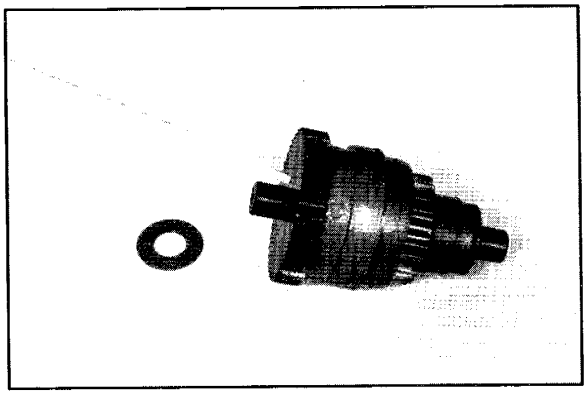
1. Install flywheel, washer, and nut. Torque flywheel to specification.

Flywheel Nut Torque:

58-72 ft. lbs. (7.85-9.81 kg-m)

Starter Drive

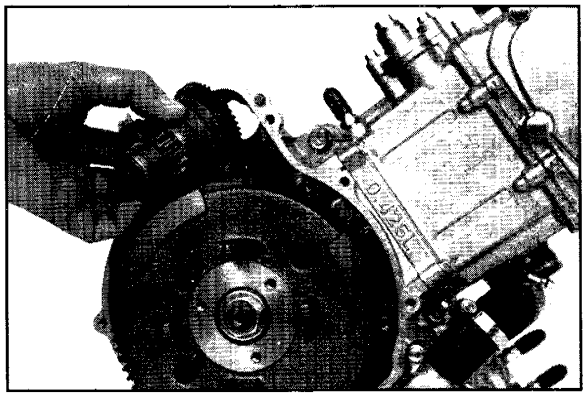
1. Be sure the washer is positioned on the back of the drive gear.



2. Apply grease to the drive bushing in the crankcase and all moving surfaces of the starter drive mechanism. Install the starter drive.
3. Install recoil housing gasket and recoil housing.

Starter Drive Grease:

PN 2871460



Assembly, Cont.

Rocker Shaft/Rocker Arm Assembly Installation

1. Assemble rocker arms, rocker shaft, and shaft supports.
2. Install and tighten rocker arm shaft locating bolt.
3. Apply molybdenum disulfide grease to the cam lobes and cam follower surfaces.
4. Rotate the engine until the cam lobes are pointing downward.
5. Be sure the dowel pins are in place and install the rocker shaft assembly.
6. Apply a light film of engine oil to the threads of the bolts and tighten evenly.

Rocker Shaft Support Tower Bolt Torque:
9 ft. lbs. (1.242 kg-m)

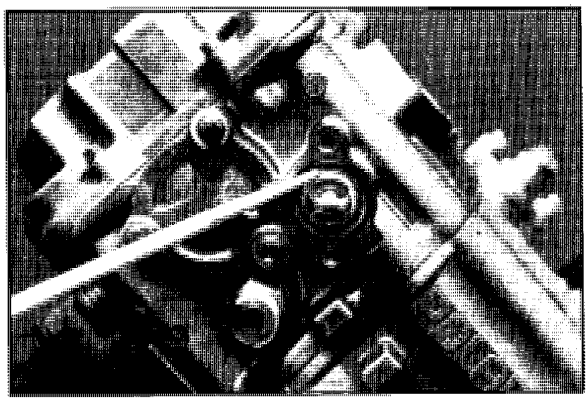
Rocker Shaft Locating Bolt Torque:
6 ft. lbs. (.828 kg-m)

7. Adjust valves according to the valve adjustment procedure found in Chapter 2, Maintenance.
8. Apply clean engine oil liberally to the valve springs, cam chain, rocker arms, and camshaft.
9. Place a new rocker cover gasket on the cylinder head and install the cover and bolts.

Rocker Cover Bolt Torque:
6 ft. lbs. (.828 kg-m)

Thermostat Installation

Install the thermostat with one of the air bleed holes positioned next to the upper thermostat cover bolt hole as shown.



Oil Pipes

Install the oil pipes with new sealing washers. Tighten all bolts evenly to specified torque.

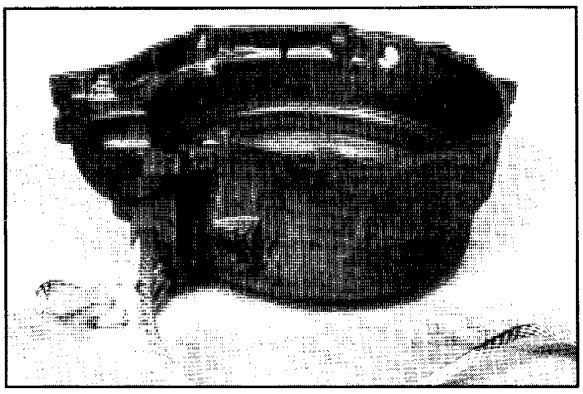
Oil Pipe Bolt Torque:
20 ft. lbs. (2.76 kg-m)

Recoil Disassembly/Inspection

CAUTION: The recoil is under spring tension. A face shield and eye protection is required during this procedure.

Replace any parts found to be worn or damaged.

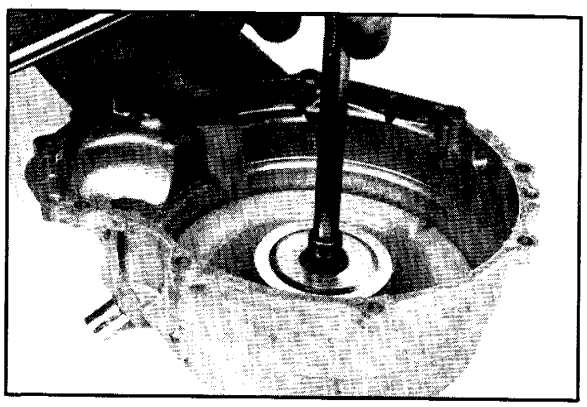
1. Remove bolts and recoil housing.
2. Pull recoil rope so it is fully extended and tie a loose knot at the rope guide bushing.

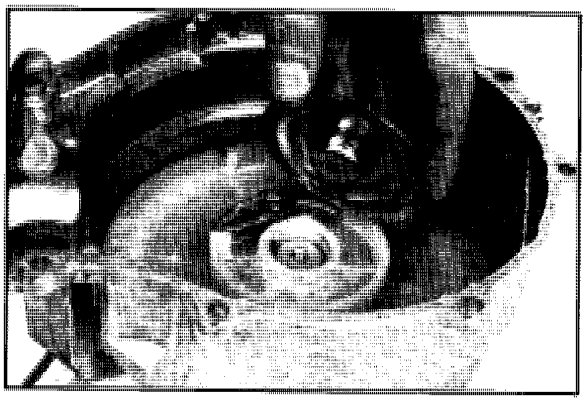


3. Check handle for cracks or damage which may allow water or dirt to enter the recoil housing through the rope. **NOTE:** The handle must also seal tightly on the recoil housing to prevent water from entering.
4. Pull knot out of of recoil reel. Untie knot. remove rope from reel.

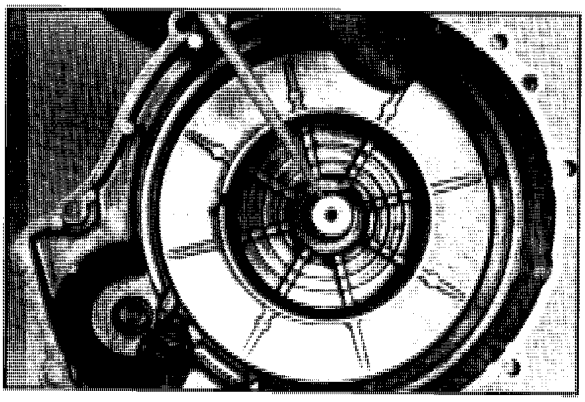
Recoil Disassembly/Inspection, Cont.

5. Slowly remove spring tension by rotating reel clockwise until all tension is removed.
6. Remove 6 mm bolt and spring washer securing friction plate. Remove friction plate. Inspect plate for wear or damage. Inspect plate friction spring for wear, damage, and proper tension. The spring should fit tightly on friction plate.
7. Remove ratchet pawl with spring and inspect. Replace spring or ratchet pawl if worn, broken, or damaged.





8. Slowly and carefully remove reel from recoil housing making sure the spring remains in the housing. Inspect the reel hub and bushing for wear.
9. Unwind rope and inspect for cuts or abrasions.
10. Inspect drive tab on hub return spring for damage. To remove hub return spring, hold outer coils in place with one hand and slowly remove spring one coil at a time from the inside out.



Recoil Assembly

CAUTION: Be sure to wear a face shield and eye protection when performing this procedure.

To install a new spring:

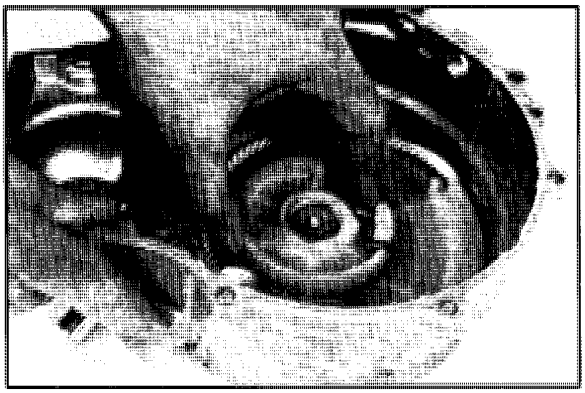
1. Place spring in housing with the end positioned so the spring spirals inward in a counterclockwise direction. See photo above.
2. Hold spring in place and cut retaining wire.

To reinstall an old spring:

3. Hook outer tab in place in recoil housing and wind spring in a counterclockwise direction one coil at a time while holding the installed coils in place.
4. Lubricate the spring with light lubricant such as Polaris Cable Lube (PN 2870510) or low temperature grease.

Recoil Assembly, Cont.

1. Route rope through guide bushing and into reel. Tie a secure knot in end of the rope.
2. Wind rope counterclockwise onto the reel, as viewed from ratchet side of reel as shown.
3. Lock rope into notch on outer edge of reel.
4. Apply a small amount of Polaris low temp grease or equivalent to the center post of the housing and the bushing.
5. Install reel into housing making sure the spring drive tab on the reel engages the spring and the reel is fully seated in the housing.
6. Apply downward pressure on the reel and rotate counterclockwise approximately 6 turns to pre-wind the spring. Continue rotating counterclockwise until rope on outer edge aligns with rope guide bushing.
7. Release rope from notch and allow reel to rewind completely. If more pre-wind is required, place rope in notch and add additional turns of pre-wind.
8. Install ratchet pawl and return spring.
9. Reinstall friction plate. **NOTE:** The friction plate must be positioned with both end tabs of the friction spring on the drive side of the ratchet.
10. Torque friction plate retaining bolt to 5-6 ft. lbs. (.69-.828 kg-m).
11. Reinstall recoil housing using a new gasket. Seal stator wire harness grommet with RTV silicone.



Spark Plug Fouling - 2 Stroke Engines

- Oil pump adjusted incorrectly
- Adjustment (pilot screw)
- Restricted air filter (main or pre-cleaner)
- Improperly assembled air intake system
- Oil pump shaft seal leaking (fills crankcase)
- Oil pump arm or reel not returning properly (cable, arm or reel sticking)
- Spark plug cap loose or faulty
- Choke cable adjustment or plunger/cable sticking
- Foreign material on choke plunger seat or plunger
- Incorrect spark plug heat range or gap
- Carburetor inlet needle and seat worn
- Jet needle and/or needle jet worn or improperly adjusted
- Excessive carburetor vibration (loose or missing needle jet locating pins)
- Loose jets in carburetor or calibration incorrect for altitude/temperature
- Incorrect float level setting
- PVT system calibrated incorrectly or components worn or mis-adjusted
- Fuel quality poor (old) or octane too high
- Low compression
- Restricted exhaust
- Weak ignition (loose coil ground, faulty coil, stator, or ETC switch)
- ETC switch mis-adjusted
- Oil line check valve leaking

Spark Plug Fouling - 4 Stroke Engines

- Spark plug cap loose or faulty
- Choke cable adjustment or plunger/cable sticking
- Foreign material on choke plunger seat or plunger
- Incorrect spark plug heat range or gap
- Carburetor inlet needle and seat worn
- Jet needle and/or needle jet worn or improperly adjusted
- Excessive carburetor vibration (loose or missing needle jet locating pins)
- Loose jets in carburetor or calibration incorrect for altitude/temperature
- Incorrect float level setting
- PVT system calibrated incorrectly or components worn or mis-adjusted
- Fuel quality poor (old) or octane too high
- Low compression
- Restricted exhaust
- Weak ignition (loose coil ground, faulty coil, stator, or ETC switch)
- ETC switch mis-adjusted
- Restricted air filter (main or pre-cleaner)
- Improperly assembled air intake system
- Restricted engine breather system
- Oil contaminated with fuel
- Restricted oil tank vent

ENGINE
2 Stroke Engine Troubleshooting

Condition	Possible Cause	Action/Possible Cause
Engine turns over but does not start	-No fuel	-Add fuel as required
	-Dirt in fuel line or filter	-Clean line, replace filter
	-Fuel will not pass through on-off valve (petcock)	-Clean or replace valve as necessary
	-Tank vent plugged	-Repair vent system
	-Carb starter circuit	-Clean or replace as needed
	-Engine flooded	-Turn off fuel and drain crankcase a. Inspect carb venting system for obstructions b. Inspect carb needle and seat
	-Low compression (below 100 PSI at sea level)	a. Inspect head gasket b. Inspect piston and cylinder (repair as required)
	-No spark	-Repair ignition system (refer to ignition troubleshooting
Engine does not turn over	-Dead battery	-Charge or replace battery (refer to battery testing)
	-Starter motor does not turn	-Repair starter (refer to starter testing)
	-Engine stuck	-Repair engine as required
Engine runs but will not idle	-Plugged carb pilot system	-Clean or replace pilot jet
	-Carb misadjusted	-Adjust as per specification
	-Choke not adjusted properly	-Adjust choke as per specification
	-Low compression	-Repair engine as required
	-Crankcase leak	-Repair crankcase as required
Engine idles but will not rev up	-Broken throttle cable	-Replace cable
	-Obstruction in air intake	-Clean or repair air intake
	-Incorrect carb jetting	-Jet as per jetting chart
	-ETC limiting speed (1989 and newer)	-Repair ETC (refer to ETC troubleshooting)
	-Reverse speed limiter limiting speed	-Repair reverse speed limiter (refer to reverse speed limiter troubleshooting chart)
	-Incorrect ignition timing	-Check and adjust ignition timing
	-Restricted exhaust system	-Repair or replace exhaust system
Engine has low power	-Cylinder, piston and ring wear or damage (check compression)	-Repair cylinder and piston as needed
	-PVT not operating properly	-Clean, repair or replace as required
	-Plugged exhaust	-Repair or replace exhaust system
Piston failure Scoring	-Lack of lubrication	-Fill oil tank and bleed pump
		-Check pump for proper operation, pinched vent line
		-Restricted oil delivery (lines, filter, check valve)
		-Oil pump drive gear failure
Melted piston top	-Engine overheating	-Install fan or check fan operation, test cooling system, loose or broken impeller
	-Lean air fuel ratio	-Clean carb and jet as per chart
	-Air leak in crankcase	-Repair as needed
	-Low octane fuel	-Use 87 octane minimum
	-Incorrect ignition timing	-Adjust timing as per specifications
	-Incorrect spark plug	-Install recommended spark plug
Skirt breakage	-Piston fatigue from scoring	-Repair cylinder (Check air filter and air box)
	-Excessive piston-to-cylinder clearance	
Excessive smoke and carbon buildup	-Oil pump misadjusted	-Synchronize pump to carb (refer to oil pump bleeding and adjustment)
	-Oil pump cable not allowing pump to return to idle position	-Lubricate or replace cable
Engine coolant found in counter balance assembly (Liquid cooled models)	-Water pump gasket	-Inspect/replace gasket
	-Water pump seal	-Replace

Engine Turns Over But Fails to Start

- No fuel
- Dirt in fuel line or filter
- Fuel will not pass through fuel valve
- Fuel pump inoperative/restricted
- Tank vent plugged
- Carb starter circuit
- Engine flooded
- Low compression (high cylinder leakage)
- No spark (Spark plug fouled)

Engine Does Not Turn Over

- Dead battery
- Starter motor does not turn
- Engine seized, rusted, or mechanical failure

Engine Runs But Will Not Idle

- Restricted carburetor pilot system
- Carburetor misadjusted
- Choke not adjusted properly
- Low compression
- Crankcase breather restricted

Engine Idles But Will Not Rev Up

- Spark plug fouled/weak spark
- Broken throttle cable
- Obstruction in air intake
- Air box removed (reinstall all intake components)
- Incorrect or restricted carburetor jetting
- ETC switch limiting speed
- Reverse speed limiter limiting speed
- Carburetor vacuum slide sticking/diaphragm damaged
- Incorrect ignition timing
- Restricted exhaust system

Engine Has Low Power

- Spark plug fouled
- Cylinder, piston, ring, or valve wear or damage (check compression)
- PVT not operating properly
- Restricted exhaust muffler
- Carburetor vacuum slide sticking/diaphragm damaged
- Dirty carburetor

Piston Failure - Scoring

- Lack of lubrication
- Dirt entering engine through cracks in air filter or ducts
- Engine oil dirty or contaminated

Excessive Smoke and Carbon Buildup

- Excessive piston-to-cylinder clearance
- Wet sumping
- Worn rings, piston, or cylinder
- Worn valve guides or seals
- Restricted breather
- Air filter dirty or contaminated

Low Compression

- Decompressor stuck
- Cylinder head gasket leak
- No valve clearance or incorrectly adjusted
- Cylinder or piston worn
- Piston rings worn, leaking, broken, or sticking
- Bent valve or stuck valve
- Valve spring broken or weak
- Valve not seating properly (bent or carbon accumulated on sealing surface)
- Rocker arm sticking

Overheating

- Low coolant level - air in system
- Faulty pressure cap or system leaks
- Lean mixture (restricted jets, vents, fuel pump or fuel valve)
- Fuel pump output weak
- Restricted radiator (internally or cooling fins)
- Water pump failure
- Cooling system restriction
- Cooling fan inoperative
- Ignition timing misadjusted
- Low oil level
- Spark plug incorrect heat range
- Faulty hot light circuit
- Thermostat stuck closed

Backfiring

- ETC or speed limiter system malfunction
- Fouled spark plug or incorrect plug or plug gap
- Carburetion faulty - lean condition
- Exhaust system air leaks
- Ignition system faulty:
  - Spark plug cap cracked/broken
  - Ignition coil faulty
  - Ignition or kill switch circuit faulty
  - Ignition timing incorrect
  - Sheared flywheel key
- Poor connections in ignition system
- System wiring wet
- Valve sticking
- Air leaks in intake
- Lean condition

EH42PL/EH50PL Cooling System Troubleshooting

Overheating

- Insufficient/wrong type coolant
- Air in system
- Thermostat stuck closed or not opening completely
- Radiator cap faulty (fails to pressurize)
- Restricted system (mud or debris in radiator fins or restriction to air flow, passages blocked in radiator, lines, pump, or water jacket)
- Water pump inoperative
- Fan motor inoperative

Temperature Too Low

- Thermostat stuck open

Leak at Water Pump Weep Hole

- Faulty water pump mechanical seal (coolant leak)
- Faulty pump shaft oil seal (oil leak)

Piston Damage Checklist - 2 Stroke Engines

(Some items may not apply to all engines)

- Oil tank empty; oil wrong type or contaminated
- Oil filter restricted
- Oil pump inoperative (drive gear, cable, pump); oil check valve restricted or faulty
- Lean carburetion or oil delivery due to: Vent lines pinched, kinked, or restricted (carburetor, oil tank, fuel tank etc.); Restricted oil or fuel passages, incorrect jetting for altitude/temperature
- Inoperative fan or low fan RPM (check fan motor amp draw-should be less than 6.5 amps; low battery, fan switch or connections, wiring)
- Cooling system, cooling fins, radiator fins restricted, air flow obstructed
- Incorrect piston to cylinder clearance
- Air leaks in intake tract / air intake ducts / mounting flange (damaged or loose)
- Foreign material ingestion
- Air in oil pump / lines
- Air in cooling system / low coolant level
- Poor fuel quality
- Restricted exhaust
- Incorrect ignition timing
- Spark plug heat range incorrect
- Fan blade incorrectly installed or damaged
- Air box, carburetor, or exhaust modified